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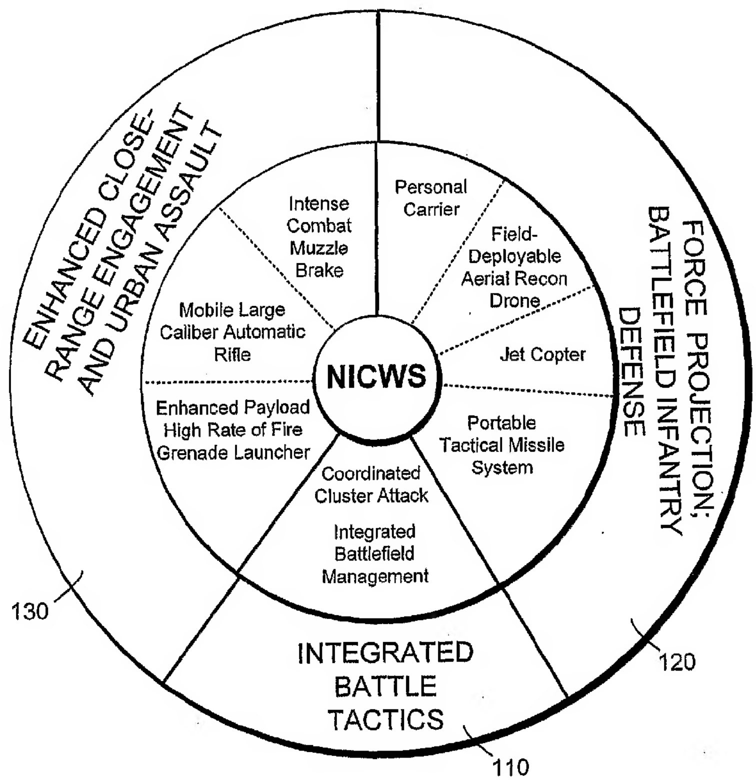

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(57) Abstract: There is presented a system for infantry combat that combines weapons, transportation, and logistical approaches to deploy a highly mobile and agile infantry-based army to effectively operate in open-field or urban warfare environments against threats ranging from individual militants to heavy armor and aircraft. Among components of the infantry combat weapons system are a large-caliber recoil-mitigated battle rifle; an automatic grenade launcher and grenade system; a personal carrier transport to convey and deploy ammunition, equipment and weapons; an improved tactical missile capable of defeating new-generation armored vehicles and aircraft; an integrated targeting and reconnaissance drone; and a jet-assisted rotary wing air vehicle.

WO 2006/091240 A2

INFANTRY COMBAT WEAPONS SYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority from U.S. Provisional Application No. 60/615,261 filed on September 30, 2004, entitled, "New Infantry Combat Weapons System," and also from a U.S. Utility Application by Edwin J. Champion, entitled, "Infantry Combat Weapons System," filed on September 28, 2005; the contents of both applications is relied upon and expressly incorporated by reference as if fully set forth herein.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

[0002] Not applicable.

BACKGROUND

Field of the Invention

[0003] The present invention relates to an infantry-based weapons system. More particularly, the invention describes weapons, transportation, and logistics approaches used to deploy a highly mobile and agile infantry-based army that can effectively operate in open-field or urban warfare environments against threats ranging from individual militants to heavy armor and aircraft.

Description of the Related Art

[0004] Infantry-based combat weapons systems have evolved over thousands of years of human history. Well-trained foot soldiers equipped with state-of-the art weaponry provided

ancient empires with the ability to prevail on every front from open battlefield to siege and assault. Augmented with highly-mobile cavalries, the overall makeup of armies changed very little until the 20th century. Then with the advent of motorized vehicles and aircraft, advances in missile systems, and long range tactical and strategic weapons, the modern armies of the emerging superpowers evolved into forces that relied primarily on heavy armor and aircraft engagement, along with long-distance missile and heavy weapon support. Accordingly, later in the 20th century, the planned role of the infantry began to diminish and was relegated nearly to a "mop-up crew" status.

[0005] Beginning in the jungles of Viet Nam, and progressing to the urban jungles that have challenged U.S. forces in Somalia and Iraq, it has become clear that advanced weapons systems and air supremacy alone are insufficient to prevail in today's hostile engagements. As the Soviet Union's dismal performance in Afghanistan demonstrates, and as the US's challenges in Somalia, Iraq, and Afghanistan confirm, smaller, more agile, infantry-based opponents have proved extremely difficult for the cold-war-era armies to successfully defeat. Yet, since Viet Nam, it has become apparent that the civilian public has demonstrated a profound distaste for protracted engagements that result in many casualties with little overall success in achieving strategic or political objectives such as regime change.

[0006] When it is necessary to engage in hostilities, it is essential that victory be achieved swiftly and with a minimal number of casualties. While extensive bombing with precision-guided munitions has demonstrated the ability to demolish known targets with almost no friendly casualties and minimal collateral damage, it has also become clear that continued bombing becomes a game of diminishing returns—protracted use of ordinance produces

progressively less damage to enemy targets while significantly impeding the ability of the target country to repair infrastructure and successfully rejoin the community of nations.

[0007] As Bevin Alexander has put it in his insightful and valuable book *How Wars are Won*, "Traditional-Fire-Maneuver tactics of individual military units, whether infantry, artillery, armor, or combinations of the three, are now out of date. Today in almost any environment, including mountains, troops massed in even small groups are extremely vulnerable." To be successful in today's combat theatres, a modern military needs to equip, train, and field an infantry force with sufficient firepower to successfully engage a variety of threats with surgical precision. What is needed is an infantry that can successfully engage targets such as distant or hidden heavy armor, terrorists in foxholes waiting to launch rocket-propelled grenades, or insurgent militia hiding in buildings. What is further needed is a means for infantry to effectively transport a significant amount of firepower and supplies while requiring a minimal logistical tail. What is also needed is a means to more rapidly deploy infantry into hot landing zones, and improve the survivability of troops and deployment platforms upon ingress or egress from hot landing zones.

SUMMARY OF THE INVENTION

[0008] In view of the foregoing, it is an object of the present invention to improve various problems associated with the prior art. To this end, an object of the invention is to provide an infantry combat weapons system with integrated battle tactics to create a next-generation infantry that is adept at handling engagements ranging from heavy armor to high-power battlefield laser systems to close-combat urban warfare environments. With the

improvements offered by the present invention, every soldier becomes his own army, capable of engaging any target thrown his way.

[0009] It is another object of this invention to provide a large-caliber automatic weapon that is capable of being shoulder-fired yet having the power for significant penetration and energy delivery beyond the standard field rifles in use in today's military. Through the use of a complementary recoil-reduction, energy absorption, and impulse mitigation techniques, the rifle of the present invention allows infantry personnel to shoulder-fire in full automatic mode cartridges such as the standard .50 BMG caliber round used by the US military. Such capability is sorely needed to provide the firepower necessary to penetrate walls in urban combat scenarios or to shoot through ceilings of buildings into floors above in order to neutralize enemy personnel that are hidden or guarding stairwells.

[0010] It is a further object of the invention to provide a grenade launcher that has an improved yield over today's hand-carried 20 mm, 25 mm, and 40 mm grenade launchers yet is capable of firing in a semi-automatic or automatic mode. By using a propulsion system similar to Gyrojet rocket-propelled rounds, the grenade launcher of the present invention is capable of firing heavier, higher-yield rounds that would produce prohibitive recoil if they were fired by traditional chambered explosive approaches. The improved grenade launcher of the present invention is lightweight, portable, can be deployed and multiple rounds rapidly fired at a moment's notice.

[0011] It is an additional object of this invention to provide a means for individual infantry personnel to effectively transport and deploy long-range weapons and battlefield supplies, without the need for large motorized platforms. The Personal Carrier of the present invention provides a two-wheel platform that soldiers can easily pull over varied terrain with

only minimal encumberment. The Personal Carrier further comprises power assist capability utilizing a battery and motor system in the wheel/axle assembly, effectively helping troops traverse hills and difficult terrain. The Personal Carrier allows soldiers to bring to the combat theatre a sufficient supply of ammunition to successfully engage targets in a variety of scenarios without being weighed down. If an emergency situation arises in the field, solders can quickly drop the personal carriers and seek cover—much more quickly than heavy strapped-on backpacks would allow. Further, coupled to the Personal Carrier is a portable tactical missile system that provides force multiplication, enabling each soldier to engage heavy armor from a safe distance. With the tactical missile system of the present invention, a mere company of infantry can lay down a swarm of anti-armor tactical missiles that can completely neutralize a column of tanks from a safe distance.

[0012] It is yet another object of the present invention to provide a reconnaissance drone to provide tactical battlefield information to soldiers. It is an object of the invention that the drone is easily field-carried and deployed. It is also an object of the invention to integrate into the drone sensors, navigation, target designation, and tracking capability to allow the drone to provide integrated targeting information to a soldier and tactical missile system and to allow the drone to autonomously keep station in a manner that allows the drone to maintain view of the target and battlefield while following the controlling soldier's movement around the battlefield.

[0013] It is yet a further object of the present invention to provide for a means for rapid ingress and egress from battlefields through the use of a jet-assisted rotary blade platform that can quickly and effectively deploy a large number of troops to landing zones while presenting only a limited time on station presence to minimize likelihood of attack. It

is a further object of the present invention to provide for a means to use rotatable and vectorable jet thrust assistance to stabilize a rotary blade platform in the event that adverse weather or damage to the aircraft endangers the aircraft's mission.

[0014] It is yet an additional object of the present invention to provide for a portable tactical missile that can either be shoulder fired or fired from a position mounted on an Personal Carrier. It is yet another object that the tactical missile be capable of defeating defensive countermeasures presented by armored targets, and be capable of supporting a variety of tracking and guidance modes. It is yet another object of the present invention to provide an integrated interface between a tactical missile, a firing and control platform, a reconnaissance drone, and a soldier's personal tactical display system. It is also an object of the present invention to provide for a tactical missile that can be fired from a position substantially removed from the soldier controlling it, and yet navigate to target without direct line of sight and around intervening terrain.

[0015] It is yet another object of the present invention to offer an integrated weapons system and tactics to enable an army infantry to defeat a broad range of enemies that may have superior armor, superior position, or may be located in difficult-to-engage situations such as urban combat environments. With the weapons and tactics of the present invention, a modest sized infantry-based army gains the capability to oppose and overcome forces that would normally cause extreme casualties and defeat.

[0016] Additional objects and advantages of the invention will be set forth in part in the description that follows, and in part will be obvious from the description, or may be learned by practice of the invention. The objects and advantages of the invention will be realized and attained by means of the elements and combinations particularly pointed out in the appended

claims. It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory only and are not restrictive of the invention, as claimed. Thus, the present invention comprises a combination of features, steps, and advantages that enable it to overcome various deficiencies of the prior art. The various characteristics described above, as well as other features, will be readily apparent to those skilled in the art upon reading the following detailed description of the preferred embodiments of the invention, and by referring to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] For a more detailed description of a preferred embodiment of the present invention, reference will now be made to the accompanying drawings, which form a part of the specification, and wherein:

FIG 1. illustrates an overall integrated block-diagram view of components of the system of the present invention, and one embodiment of how those components interrelate;

FIG. 2 illustrates one embodiment of the present invention on an open battlefield;

FIG. U2A depicts one illustration of the personal carrier of the present invention, being hauled by a soldier;

FIG. U2b illustrates another view of the personal carrier of the present invention;

FIG. U2c illustrates one embodiment of a personal carrier of the present invention preparing to fire a tactical missile;

FIG. U2d illustrates one embodiment of a personal carrier of the present invention firing a tactical missile;

FIG. W1a depicts one embodiment of the jet copter conveyance of the present invention;

FIG. W1b depicts one embodiment of the jet copter conveyance of the present invention approaching a landing zone with nacelles parallel to the flight path;

FIG. W1c illustrates initial approach of the jet copter of the present invention toward a landing zone;

FIG. W1d depicts a jet copter of the present invention continuing to approach a landing zone while rotating nacelles to reverse downward velocity;

FIG. W1e illustrates the jet copter of the present invention continuing to approach a landing zone while leveling its attitude;

FIG. W1f depicts an embodiment of the jet copter unloading troops from an opening in the belly of its fuselage;

FIG. W1g illustrates one mode of the jet copter's rapid egress from a landing zone with rotatable engine nacelles vectored to produce the vertical and forward thrust;

FIG. W1h illustrates the jet copter assuming level attitude after its egress from the landing zone;

FIG. W1i illustrates a prior art bomblet such as the M85 Self-Destruct Dual Purpose Scatterable Munition;

FIG. W1j illustrates the cross section of a prior art bomblet such as the M85 Self-Destruct Dual Purpose Scatterable Munition;

FIG. V1a illustrates a prior art M79 40 mm grenade launcher;

FIG. V1b illustrates a partially disassembled view of a prior art M79 40 mm grenade launcher;

FIG. V1c illustrates a prior art MK 19 grenade launcher;

FIG. V1d depicts a prior art MK 47 grenade launcher;

FIG. V1e shows a cutaway view of a prior art 40 mm grenade;

FIG. V1f illustrates a prior art OICW rifle and launcher;

FIG. V1g depicts a prior art 20 mm HEAB Grenade;

FIG. V1h illustrates an example of one embodiment of the present grenade invention in cross section;

FIG. V1i depicts one embodiment of the base/bottom of the present grenade invention;

FIG. V1j depicts another embodiment of the base/bottom of the present grenade invention;

FIG. V1k illustrates a rear/bottom view of a prior art Gyrojet round;

FIG. V1m depicts one embodiment of the automatic grenade launcher of the present invention in partial cross-section view;

FIGS. V2a-V2g illustrate an embodiment of the automatic grenade launcher of the present invention, operating to fire a grenade of the present invention;

FIGS. V3a-j illustrate targeting and downrange operation of the grenade launcher of the present invention;

FIG. Q1a illustrates a prior art Dragon Eye unmanned aerial vehicle;

FIG. Q1b illustrates a prior art Raven unmanned aerial vehicle;

FIG. Q1c depicts one embodiment of the Recon Bird unmanned aerial vehicle of the present invention;

FIG. Q1d illustrates a collapsed view of the Recon Bird of the present invention in preparation for storage or deployment.

FIG. Q1e depicts a prior art conceptual mesicopter design;

FIG. Q1f illustrates a second prior art conceptual mesicopter design;

FIG. U3a is a view of a prior art TOW missile;

FIGS. U3b-U3c illustrate views of prior art Hellfire missiles;

FIG. U3d illustrates a prior art cross-section view of an FCLAS grenade;

FIG. U3e shows a prior art depiction of a perimeter defense system such as FCLAS;

FIG. U1a illustrates one embodiment of the tactical missile of the present invention;

FIG. U1b depicts one embodiment of a dart of the present invention;

FIG. U1c illustrates one embodiment of the tactical missile of the present invention with the first stage motor separated from the body of the missile;

FIG. U1d shows one embodiment of the tactical missile of the present invention with the main missile motor ignited and a dart separating from the missile;

FIG. U1e shows one embodiment of the tactical missile of the present invention with the main missile motor ignited and a second dart separating from the missile;

FIG. U1f shows one embodiment of the tactical missile of the present invention with the main missile motor ignited and a third dart separating from the missile;

FIG. U1g illustrates one embodiment of the darts of the present invention flying a spatially-diverse trajectory towards a target;

FIG. U1h shows one of the darts of the present invention intercepting a defensive system such as the FCLAS system;

FIG. U1i illustrates impact of one of the darts of the present invention upon a target or in proximity to a reactive armor blast;

FIG. U1j illustrates impact of another dart of the present invention upon a target;

FIG. U1k shows one embodiment of the missile of the present invention on trajectory to impact with a target;

FIG. U1l illustrates impact of one embodiment of the missile of the present invention upon a target;

FIG. R1 depicts an exploded part view of a prior art M14 Rifle;

FIG. S1 illustrates one embodiment of the low-recoil rifle of the present invention;

FIGS. S2-S12 illustrate modes of gas operation in a cutaway view of the low-recoil rifle of the present invention;

FIGS. S13-S15 illustrate one embodiment of the low-recoil rifle of the present invention, whereby the barrel is allowed to recoil after the rifle is fired;

FIGS. S16-S25 illustrate a close-up view of a cutaway of the rifle of the present invention, showing the process of feeding a cartridge from a magazine;

FIGS. S27-S29 illustrate the rifle of the present invention with cutaways showing recoil mitigation springs and recoil guide rods;

FIG. S30 illustrates a close-up cutaway view of the receiver and chamber area of the rifle of the present invention;

FIG. S31 depicts one embodiment of the rifle of the present invention showing recoil guide rods and recoil mitigation springs within the stock of the rifle in cutaway view;

FIG. B1 illustrates a bottom view of the rifle receiver of present invention;

FIG. B2 shows a cutaway view of the receiver, and chamber section of one embodiment of the rifle of the present invention;

FIGS. B3-B5 illustrate a view of the barrel of the rifle of the present invention, engaged with a barrel guide;

FIGS. B7-B11 show embodiments through cross sectional views of the barrel and receiver portions of the rifle of the present invention;

FIG. B12 illustrates the barrel guide extending from the receiver of the rifle of the present invention;

FIG. B14 shows a close-up view of one embodiment of the chamber-end opening of the barrel of the present rifle invention;

FIGS. B15-B17 illustrate latch engagement mechanisms for the recoil guides for the rifle of the present invention;

FIGS. B18-B21 show various views of one embodiment of recoil guides and springs for the barrel of the present rifle invention;

FIGS. B22-B25 illustrate additional views of latch timing mechanisms for the barrel recoil mechanism of the rifle of the present invention;

FIG. C1 shows another embodiment of the rifle of the present invention;

FIG. C5 illustrates a side cutaway view of the stock of the rifle of the present invention, illustrating recoil springs therein;

FIG. C6 shows a top view of the stock of the rifle of the present invention, illustrating placement of recoil springs and rods therein;

FIG. C7 shows a top view of the recoil spring and rod section of the rear end of the rifle barrel of the present invention, not located within the rifle stock;

FIG. C9 illustrates one embodiment of the rifle of without the stock present;

FIG. C10 shows the rear section of the receiver of the rifle of the present invention, wherein the recoil guide rods are shown having passed through the rear receiver section and are residing within the recoil springs;

FIGS. C12-C13 illustrate one embodiment of the barrel of the rifle of the present invention, with recoil guide rods and recoil springs shown attached to the rear of the barrel;

FIG. C15 shows another view of one embodiment the receiver/barrel assembly of the rifle of the present invention;

FIG. C18 shows another view of one embodiment of the recoil springs of the rifle of the present invention located within the rifle stock;

FIGS. C19-C20 show close in views of the engagement of recoil rods with recoil springs of the rifle of the present invention;

FIGS. D1-D9 provide various illustrations of an alternative embodiment of the rifle of the present invention, whereby recoil springs are located along the side of the rifle barrel;

FIGS. E1-E18 provide various illustrations of an alternative embodiment of the rifle of the present invention, whereby a recoil spring surrounds the rifle barrel;

FIGS. F1-F18 illustrate one embodiment the recoil action of a barrel within the rifle of the present invention, further depicting the flow of gas through orifices to a gas piston and recoil mitigation chambers;

FIGS. G1-G16 illustrate various embodiments of recoil mitigation springs, and mechanisms for further using gas flow to mitigate recoil;

FIGS. H1-H11 illustrate a vacuum impedance reduction mechanism for improving recoil of the barrel of the present invention; and,

FIGS. L1-L22 illustrate additional embodiments of the receiver, barrel, and bolt latch timing system of the rifle of the present invention.

DETAILED DESCRIPTION

[0018] Reference will now be made in detail to exemplary embodiments of the invention, examples of which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers will be used throughout the drawings to refer to the same or like parts.

The New Infantry Combat Weapons System and Tactics

[0019] Mankind has been fighting wars with infantry long before the earliest recorded history. The first major innovation in infantry warfare, however, came in the form of the phalanx, developed in ancient Greece. By bringing infantry troops together in close rank and depth of proximity, then interlocking shields, a tight group of soldiers could move and operate to resist most arrow-based attacks, as well as withstand initial contact with weapons from a charging enemy. However, as time progressed, weapons such as heavy pikes, onagers, stingers, trebuchet, and eventually cannons were developed to deliver a strong enough missile to penetrate the shield perimeter defense of the phalanx and thereby neutralize the infantry's primary open-field advantage. Modern warfare likewise presents such effective anti-infantry weapons as cluster bombs, artillery, heavy armor, and MLRS rockets. With odds seemingly stacked against infantry, there needs to be a "new phalanx" that is capable of arming infantry with weapons of sufficient power and methods of use that allow them not only to defend themselves but to take tactical initiative away from a more heavily-armed opponent.

[0020] Referring to FIG. 1, the large caliber rifles with recoil mitigation, recon drones, tactical missile system, improved grenade launcher, Personal Carrier, and rapid deployment systems and technology of the present invention integrate to provide a "virtual phalanx." In this integrated warfare approach, infantry are equipped with superior firepower that can

neutralize targets ranging from heavy armor to aircraft to enemies behind walls and in foxholes, and given the ability to project force quickly and effectively. For instance, as illustrated in one embodiment of the present invention in FIG. 2, on the open battlefield, no soldier is closer than two hundred and fifty yards from the closest soldier to him. As a result, large area-effect weapons cause only limited damage since only perhaps one soldier is harmed by the blast. Likewise, artillery or MLRS attacks will easily be countered by the launching of the disclosed tactical missiles. Since the tactical missiles of the present invention can be operated unmanned from a significant distance away, the soldier is not placed in harm's way once an enemy spots a location of missile launch. With the use of the recon drones of the present invention, the eyes of the infantry are extended over mountains and for miles away. Together with the weapons disclosed herein, an infantry can project power well beyond the few hundred yard range of conventional infantry units. Once individuals are equipped with the weapons and tactics of the present invention, they now have the ability to offer a swarm-of-weapons attack on an enemy without presenting a single, centralized target to be counterattacked. The enemy's confusion multiplies as the damage to the enemy continues to accrue, yet the enemy is unable to mount an effective response to this diffuse force because there is no small corps of troops to bombard.

[0021] The present invention also easily excels in urban combat situations. The present invention provides the capability of soldiers to field and support larger caliber rifles such as the .338 Lapua cartridge along with a fully automatic .50 caliber eighteen pound specialized urban combat rifle as disclosed more fully below. All of these cartridges are fired from rifles with full automatic capability or at the very least three round burst capability. This spectrum of urban combat capability—7.62 NATO, 300 WSM, 300 Tac Mag, .338 Lapua, and .50 caliber is made manageable on full automatic fire and thus feasible for infantry, for the first time, by the use of

the intense combat muzzle brake, as more fully disclosed below, and with the advanced recoil mitigation techniques of the present invention.

The Personal Carrier

[0022] Mobility is a key factor in infantry combat effectiveness. However, soldiers with supplies and weapons, while highly mobile, pose no serious threat to an enemy. While field supplies such as personal gear, ammunition, provisions, and weapons are critical to sustain the combat effectiveness of a fielded infantry, a point of diminishing returns quickly arises when soldiers become tasked with the burden of carrying more and more equipment. After a point, requiring soldiers to haul additional field supplies only serves to impede mobility, diminish response time, and degrade combat readiness. There exists in the current art, therefore, a tradeoff between equipping infantry soldiers with field supplies and the combat effectiveness provided by having an agile fighting force. The present invention serves to overcome many of the problems presented by equipping soldiers with a substantial amount of bulky field provisions, while dramatically increasing infantry fighting power, force projection, and field longevity.

[0023] By way of background, hand carts, wheelbarrows, and hand cargo trucks have been in use for thousands of years. Historians believe the origin of the wheelbarrow and pull cart date to the Chinese Han dynasty (206BC - 220AD). Chinese General Chuko Liang (181-234 AD) is generally credited with this important invention, and in recognizing the importance of this innovation for China's armies, China attempted to keep their use secret; eventually they were recorded in military specifications that date to General Liang's time.

[0024] Armies throughout history have continued to use carts to offburden infantry soldiers and improve mobility. Soldiers from Napoleon's ranks to General William Darby's WWII-era cart-equipped rangers have used carts to increase fighting effectiveness. Yet today, modern infantry has almost completely abandoned the utility provided by these straightforward devices, and has failed to recognize the potential for improvements that may be offered by modifications to prior art designs.

[0025] The present invention supports the New Infantry Combat Weapons System by providing a number of solutions to problems encountered by infantry. It is an object of the present invention to allow infantry to carry weapons and ammunition that have more effective calibers than the woefully undersized and underpowered .223 caliber (5.56 mm) round currently in use in the U.S. Military. It is a further object of the present invention to allow troops to easily transport over 200 pounds of field gear including large ammunition magazines (e.g. capable of holding 100 rounds) in addition to a two-week supply of food and water with minimal encumberment. It is yet a further object of the present invention to provide every soldier with the means to transport one or more Tactical Missiles in addition to a significant amount of field supplies. It is yet another object of the present invention to provide an integrated firing platform for a tactical missile, that communicates between a soldier's tactical display and a reconnaissance drone. It is a further object of the present invention to provide assisted propulsion to a carrying cart that may automatically assist the conveyance of materials across difficult terrain, and automatically provide braking upon downhill decent.

[0026] The personal carrier of the present invention is illustrated in FIGs. U2a, U2b, U2c, and U2d. Turning to FIG. U2a, the personal carrier comprises an elongate substantially rectanguloid chassis (U2a1) with an axle end, a handle end, diagonal cross brace members

(U2a2) connected between elongate corner members of the chassis (U2a1) and elongate handles (U2a3) extending from the handle end. As illustrated in FIG. U2b, the elongate handles (U2a3) are hingedly or articulably attached to the chassis (U2a1) so that they may be folded and stowed for efficient storage and transportation of the personal carrier in a vehicle such as a cargo plane or on the side of a vehicle such as a helicopter or utility truck. The rectanguloid chassis (U2a1) and cross braces (U2a2) further define a cargo space (U2a4) within the interior of the chassis frame, and a solid panel (not shown) further defines a cargo deck on the bottom of the chassis (U2a1). A cargo door (U2a7) hingedly attaches to the bottom of the axle end of the chassis (U2a1) and releasably latchedly closes to define a closed axle end for the chassis (U2a1). Turning to FIGs. U2b and U2c, an elongate H-braced stand is hingedly attached to the bottom of the personal carrier chassis (U2a1), and may be spring loaded or latchably held against the bottom of personal carrier chassis (U2a1) when the personal carrier is either stowed or in use by a soldier or marine.

[0027] The personal carrier further comprises an axle (U2a5) attached to the axle end of the chassis (U2a1) and wheel assemblies (U2a6) rotatably attached to the axle (U2a1). The axle (U2a5) and wheel assemblies (U2a6) optionally further comprise an electric motor power assist system and transmission (not shown). Examples of motor drive systems are well known in the art, for instance in U.S. Patent Number 6,302,230 "Personal Mobility Vehicles And Methods," U.S. Patent Number 6,367,817 "Personal Mobility Vehicles And Methods," U.S. Patent No 5,971,091, "Transportation Vehicles and Methods"; and some versions of motor-assisted carts exist, such as that described in U.S. Patent Number 6,173,799, "Motor-Assisted Single-Wheeled Cart," the disclosure of all of which are fully incorporated by reference herein for all purposes. Any of such types of motor drive systems, with an interconnected battery

assembly (not shown), may be adapted to provide power assistance and drive to the axle (U2a5) and wheel assemblies (U2a6). It is also provided in the present invention that the motor drive capability integrated into the personal carrier of the present invention may also be configured to provide electromagnetic regenerative braking; that is, the motors are capable of being configured to provide counter-torque to oppose the forward motion of the axle/wheel assemblies, and as a result, produce electric current that may be used to charge the battery assembly. Examples of systems that could be adapted to the present invention is disclosed in U.S. Patent Number 6,794,834, "Electric Vehicle," and U.S. Patent Number 6,782,877, "Method and Arrangement for Controlling a Charger," the disclosures of which are fully incorporated by reference herein for all purposes.

[0028] The personal carrier of the present invention also serves as a weapons and communications platform to dramatically multiply the force that a single "army-of-one" soldier or marine can assert against an enemy. The personal carrier of the present invention may be optionally equipped with a tactical missile (U2a9), tactical missile launch system (U2a8), and integrated fire control, guidance, and communication system (not shown). In one embodiment, an optional hand-deployable lasing system (not shown) is integrated with the fire control system so that at a moment's notice, a solder may point the hand deployable lasing system toward a target, aim through a sight attached to the lasing system, and pull a trigger, instantly providing a firing signal to the tactical missile system (U2a8) that is attached to the Personal Carrier. The Tactical Missile thus fired may be guided to the target by beam-riding SACLOS mode (as described in the Tactical Missile system herein). Such a method would prove especially useful in either emergency conditions or when aircraft are to be the target of the Tactical Missile attack.

[0029] The Personal Carrier is further comprised of a link (not shown) to the recon bird of the present invention, implemented either in a spoolable wired connection, a spoolable optical fiber connection, a wireless radio frequency link, a wireless infrared link, or any combination of those approaches. In one embodiment, the battery assembly of the personal carrier of the present invention provides electrical power through a wired link to the recon bird, so that the recon bird drone may stay aloft for an extended period using electric motors powered by the battery assembly of the personal carrier. The above-referenced integrated control, guidance and communication system provides a pathway for data to be transmitted between a soldier's tactical display, the recon bird (Q1c10), and the tactical missile (U1a1). More modes of the electronics systems that further comprise the personal carrier are described in relation to alternate embodiments herein.

[0030] The personal carrier of the present invention may alternatively be carried by hand, with the soldier grasping each of the elongate handles (U2a3) by hand and pulling in a manner such as a "reverse wheelbarrow." Alternatively, a yoke and harness system may be utilized, such as a quick-release coupling to an All-Purpose Lightweight Individual Carrying Equipment (ALICE) and/or belt/harness system, so that the soldier may pull the personal carrier without needing to grasp handles. In yet another embodiment, the personal carrier of the present invention is also capable of being towed behind a vehicle through a hingedly or slidably attached tow ball/hook receiver. In this manner, the personal carrier platform can easily be carried trailer-pulled behind motorcycles, ATV's, HMMVW's, or duce-and-a-half utility trucks. In an additional embodiment of the present invention, the axle end of the chassis (U2a1) further comprises a deployable hitch that may pivitoally attaches to a second personal carrier of the present invention, the second personal carrier places its handle end in

communication with the axle end of the first personal carrier, and thus forms a daisy chain of two (or more) personal carriers that can be towed by a vehicle. In this manner, a string of daisy-chain connected personal carriers can be towed behind a single vehicle, and a squad of soldiers being ferried by a truck have readily available a substantial firepower and supplies wherever they are being deployed. Therefore, such an ability to transport daisy-chained personal carriers with the men that need them substantially reduces the logistics tail needed to immediately provide provisions, ammunition, and weapons. As an additional tactical advantage of such a configuration, a Personal Carrier-equipped squad is self-contained and therefore rapidly deployed at a moment's notice to assert a heavy firepower in the urban or open battlefield environment.

[0031] As mentioned previously, the Personal Carrier comprises batteries, controllers, and motor/generator assemblies that are capable of providing a boost in acceleration to the wheel assemblies to assist a soldier or marine with pulling a carrier in the field. Such a boost could be of great aid if the soldier is ascending a steep hill, negotiating a bog or heavy grass, running under fire, or just attempting to overcome inertia and the static coefficient of friction that makes starting a vehicle rolling much more difficult. While it is anticipated that in the preferred embodiment the boost system does not necessary operate continuously, e.g. the soldier does most of the pulling except when a boost is needed, it is possible, depending on the state of the battery, that continuous thrust will be provided by the motors to reduce the soldier's exertion in pulling the load. Such may be useful, for instance, if the soldier is injured or wounded.

[0032] The electrical boost system of the personal carrier may be actuated mechanically, such as a simple switch, a rotatable motorcycle-accelerator-type grip on one of

the handles (U2a3), or automatically through a push-pull force sensor system. The carrier further comprises a switch that may disable electrical boost, or a dial selector that may choose the amount of boost provided or the conditions under which boost is provided. The carrier also comprises an optional tilt sensor that is capable of disabling the boost system if the carrier assumes a position that could harm a person in proximity to the carrier, e.g. if the carrier is laid down horizontally on the ground.

[0033] One embodiment of the present personal carrier invention comprises a strain gauge, spring and potentiometer, or other force measurement system that senses the mechanical energy being delivered to the personal carrier to move it (e.g. through the force applied to the handles (U2a3) to pull the personal carrier) and interfaces with circuitry in the personal carrier that controls the boost motors. Such configuration, for instance, could be implemented through strain gauges integrated into the handles (U2a3) and/or chassis (U2a1) of the personal carrier and electrically connected to the Personal Carrier's controller. If the present invention's Personal Carrier boost assist system is set to an automatic boost assist mode, then a predetermined (or switch-selectable) threshold force is used to determine whether to provide boost assistance to the wheel assemblies. For example in FIG. U2a, if the soldier (U2a10) is preparing to pull the Personal Carrier, the forward force being applied by the soldier is sensed, and if it passes a threshold, for instance 100 Newtons (or about 22 pounds force), automatic boost is applied to assist the soldier in beginning forward motion. In one embodiment, the amount of boost applied is related to the amount of pull force being provided by the soldier, e.g. the harder the soldier pulls on the Personal Carrier, the more boost assist is provided to the wheel assemblies.

[0034] The Personal Carrier of the present invention is also further comprised of brake assemblies that prevent the carrier in a steep downhill attitude from endangering the soldier in front of the carrier. A mechanical disk and caliper or brake shoe and drum system may be employed, with hand actuators that control the brakes available for use on the handles (U2a3). In yet another embodiment of the Personal Carrier, the motor assemblies are capable of controlled conversion to generation mode, which provides dynamic braking in downhill traversals. In one embodiment, the dynamic braking is controlled by the previously mentioned strain sensor system that detects that the Personal Carrier is pushing against the soldier (U2a10) and therefore braking should be applied. In another embodiment, the amount of dynamic braking applied to reduce the load on the soldier in downhill motion is related to the amount of forward force being applied by the Personal Carrier to the soldier. Put another way, the steeper the hill, the more force (due to gravity) the Personal Carrier exerts upon the soldier, and the more the sensor/controller system actuates the dynamic brakes. In one embodiment, the electrical energy generated by the dynamic brakes is returned through charging circuitry to the Personal Carrier's battery assemblies, therefore batteries are charged as the Personal Carrier descends hills. Likewise, when the Personal Carrier is being towed, a selector switch can be turned on to turn the dynamic braking system into a charger, and the batteries are charged as the Personal Carrier is being towed, and the charger automatically disables charging when the batteries are at full capacity. In yet another embodiment, the Personal Carrier further comprises foldable and/or deployable solar panels that are connected to its battery charging system, so that the batteries can be recharged in the field by exposure to light. In another embodiment, the battery charge controlling circuitry automatically

prevents electrical boost assist when the Personal Carriers' battery charge level falls below a certain threshold, e.g. 30 percent of full charge.

Jet Copter

[0035] The NICWS system provides for the effective assertion of force through the rapid and safe deployment of infantry to landing zones that are within effective striking distance of the enemy. The Jet Copter embodiment of the present invention meets that challenge.

[0036] Since the Korean and Viet Nam wars, helicopters have been used by the military to ferry troops and supplies to battlefield fronts. Smaller helicopters such as the UH-1 "Hueys" were fairly maneuverable but carried a relatively small number of troops compared to the more attack-susceptible tandem-rotor CH-47 Chinook. The most dangerous part of the ferry mission is generally insertion or extraction of troops from "hot LZ's" or landing zones that are under fire. Yet current efforts by the Department of Defense to develop an agile troop platform (the V-22 Osprey) have resulted in an air vehicle that must expend tremendous time converting from rotary wing mode to fixed wing mode (approximately 12 seconds hovering above the LZ) and thereby rendering itself extremely vulnerable to ground and air-to-air fire. The V-22 is also limited in its capacity to only carry up to 24 troops. To provide for a deployment or pickup of more than a handful of troops, a transportation system is needed to provide an ingress and egress from landing zones that takes only a fraction of the time that the current Chinook platforms require. What is further needed is a rotary wing aircraft that can rapidly accelerate and decelerate to provide a more effective cargo and troop delivery platform.

[0037] Referring to FIG. W1a, The Jet Copter of the present invention comprises a platform similar in structure to the CH-47 Chinook helicopter having tandem counter-rotating blades (W1a1). However, the Jet Copter comprises four, rather than two jet engine nacelles ((W1a2), the fourth nacelle at aft portside of aircraft is not shown on this drawing, but similar in operation and placement to the aft starboard nacelle, and is visible in FIG. W1h), and each nacelle (W1a2) is independently rotatable about a horizontal midline axis (perpendicular to its lengthwise, or longitudinal axis). The rotation of each nacelle (W1a2) is controllable by the Jet Copter's thrust vector management system, integrated into cockpit controls and flight management system (not shown).

[0038] The role of the independently rotatable nacelles becomes clear when the FIGs. W1b-W1h are studied. In W1b, the Jet Copter is approaching a landing zone, with its engine nacelles parallel to the flight path to increase forward velocity. Upon initial approach to the Landing Zone (or LZ), the Jet Copter may change aspect to begin to make a very aggressive dive to reduce the amount of time spent approaching the LZ, and therefore reduce the likelihood of damage from ground-based weapons fire. With its vectored jet thrust, the Jet Copter has more the agility of a dragonfly than the bumblebee-like clumsiness of rotary wing or V-22 aircraft. This initial approach is shown in FIG. W1c, whereby the engine nacelles are beginning to rotate to prepare for rapid deceleration and landing. In FIG. W1d, the Jet Copter begins to approach the LZ, still maintaining the steep angle of attack, while the nacelles have rotated to provide thrust in a direction to dramatically slow the helicopter's approach toward the ground. Next, in FIG. W1e, the jet copter begins to level its attitude while maintaining a rapid decent to the LZ, with the jet nacelles rotated in such a direction to slow forward velocity to a minimum while controlling vertical decent. In FIG. W1f, the Jet Copter is shown unloading

troops from an opening in the belly of its fuselage, allowing the troops to quickly hit the ground, clear the LZ, and seek cover. In one embodiment, armored doors (such as those constructed with advanced composites such as Kevlar) open hingedly downward to allow the troop egress, providing a temporary shield while the infantry begins its deployment. This design also allows for the quick deployment of logistics equipment such as bundles containing equipment such as the Personal Carrier defined herein. The troops, along with an effective quantity of defensive and offensive equipment, can be safely delivered in a rapid manner by a platform that is capable of appearing and disappearing before the enemy often has time to organize a planned counterattack. FIG. W1g illustrates the Jet Copter's ability for rapid egress from the LZ, with the rotatable engine nacelles vectored to produce the optimal vertical and forward thrust to move the aircraft quickly out of ground gunfire range. Finally, with the Jet Copter having successfully exited the LZ, the nacelles are angled toward the axis of flight, assisting with the forward velocity of the aircraft (see FIG. W1h).

[0039] An additional advantage of the rotating nacelles of the jet copter comes into play regarding disaster recovery. If a prior art helicopter's main rotor engine fails, the pilot normally has no choice but to enter a autorotation and attempt to land the helicopter. With the ability of the Jet Copter to vector thrust in a direction other than along the axis of travel, the pilot may choose to land in a more controlled fashion, extend the landing well past the point that autorotation would allow, or perhaps continue on the mission with the main rotor(s) configured as a gyrocopter would, e.g. in continued autorotation with the jet engines providing the necessary thrust to maintain sufficient forward velocity for autorotation.

[0040] As a further advantage of the present invention, the rotatable engine nacelles provide for lift to keep the jet copter aloft for sufficient time to complete its mission. With the

high thrust to weight ratio of jet engines, it is possible that even one or two of the jet nacelles could fail and still provide sufficient supplementary lift to achieve mission success. Likewise, through the use of an automatic adaptive stabilization control system such as those utilizing neural nets, the vectorable thrust provided by the engine nacelles not only can counteract equipment or hydraulic failures but may also stabilize the aircraft as it is being buffeted by turbulence, microbursts, or ground effect winds. Such a control system may be implemented with principles based on those discussed in the paper "Model Predictive Neural Control for Aggressive Helicopter Maneuvers," by Eric A. Wan Et. Al, published by Oregon Health and Sciences University, Beaverton, OR, 2003, the disclosure of which is fully incorporated by reference herein for all purposes. The automatic stabilization system can be programmed to automatically stabilize the flight path of the jet copter in the event of a sudden event such as a massive hydraulic failure or wind shear, thus providing sufficient time to prevent a crash when human pilots would not have been able to react quickly enough. Through this automatic stabilization system, the aircraft gains a high rate of mission survivability, even when partially damaged or when having to fly under extreme adverse weather conditions—a situation that many rotary wing platforms could not surmount.

[0041] Yet another advantage provided by the present invention is the ability to vector thrust laterally away from the base of the airframe. This ability for jet nozzle vectoring is a strong advantage, for instance, when the aircraft lands to deploy troops. By angling the thrust of the jet engines laterally away from the base of the aircraft, jet blast and foreign object damage that may harm troops can be eliminated. Even though in this scenario, the thrust is being vectored laterally away from the airframe, the jet engines still maintain sufficient net vertical thrust to provide rapid egress from the landing zone.

[0042] A further improvement of the Jet Copter is the addition of a weapons pod (not shown) that is capable of deploying a scattered spray of bomblets horizontally from the fuselage of the aircraft that then drop down onto a ground target. While cluster munitions such as the United States Military's Rockeye bombs exist, there is a need to have the ability to deploy from a helicopter platform a group of cluster bombs at a landing site to neutralize or force enemies to cease firing and take cover, further preventing the likelihood that an aircraft or infantry will take fire.

[0043] The capability of the present invention to deploy a horizontal spray of cluster munitions provides the means to rapidly neutralize ground forces in a hot LZ prior to landing, or potentially destroy armored vehicles or antiaircraft platforms. FIG. W1i illustrates one bomblet that is ideal for this task: an M85 Self-Destruct Dual Purpose Scatterable Munition (its cross section is shown in FIG W1j). The M85 comprises a shape-charge explosive inside of a frangible metal case and fusing mechanism that causes the bomblet to detonate as the munition falls to the ground after being dispensed. The M85 provides an antipersonnel effect from the shrapnel burst after detonation, and a shape charge fires a potent downward explosion into any building or machine upon which it falls. As armored vehicles are generally lightly armored on their top surfaces, this presents a significant opportunity to destroy armored vehicles that could prove deadly to an infantry that had recently been delivered to a nearby LZ.

[0044] One problem with cluster munitions, however, is the significant number of unexploded rounds or duds that remain after these munitions have been deployed. Dud rounds present a hazard to indigenous population (especially curious children) as well as friendly forces that need to enter a previously cluster-bombed area. However, modern cluster munitions such as the M85 employ built-in self destruct mechanisms to ensure that no hazardous duds are

encountered by friendly forces once deployed by the Jet Copter. With a weapons pod loaded with such cluster munitions, the Jet Copter could greatly increase the success of the mission by suppressing ground defense forces and destroying vehicles.

Portable, Free-Recoil Automatic Grenade Launcher (P-FRAG-L) and Enhanced-Yield Rocket Grenade (ERG)

[0045] By way of background, grenade launchers in general are well known and have been used by government and militia organizations for years. For example, referring to Figures V1a and V1b, there is shown the prior art M79 40 mm grenade launcher used by the United States military. As an improvement of the M79, a grenade launcher labeled the M203 was developed to attach onto the bottom of an infantry rifle, so that the solder might be able to deploy either weapon at a moment's notice. As is the case with many prior art grenade launchers, the M79 is a single-shot, break-open, breach-loading weapon. For each round fired, a soldier must break open the breach, remove any prior spent shell, place another 40 mm round in the chamber, close and lock, and then take aim and fire. Even in the commonly-available RPG 7, each rocket propelled grenade must be attached to the firing stock manually, then the target must be re-acquired before firing may occur. While reasonably portable, these manually-operated prior art grenade launchers suffer from an extremely limited rate of fire.

[0046] Automatic grenade launchers such as the Mark 19 (FIG. V1c) and Mark 47 (FIG. V1d) 40 mm grenade launchers exist; however, they suffer from severe size and weight limitations. The Mark 19 automatic grenade launcher is tripod/platform mounted, weighs approximately 138 pounds with its base and tripod, and requires bulky, belt-fed ammunition, while the newer Mark 47 automatic grenade launcher still weighs almost 40 pounds without

sight, ammunition, or tripod. Two-man crews are frequently required to set up and operate these bulky weapons, creating a further drain on resources, and the significant emplacement time reduces their effectiveness in rapidly bringing firepower to bear on a target. Further, use of such bulky prior-art automatic grenade launchers is almost precluded in a highly fluid and mobile urban assault environment, except for possible scenarios that can be supported by mounting the grenade launchers on vehicles. What is needed is a lightweight grenade launcher that can be carried and fired by an infantry soldier (like the M79) that is further capable of launching grenades automatically or semi-automatically.

[0047] Referring to FIG. V1e, a cutaway drawing of prior art 40 mm grenade similar to those in use in the U.S. military (e.g. the M403) is shown. As the figure illustrates, a substantial portion of the volume of the ordinance is dedicated to the fusing assembly and the low pressure cavity area necessary to mitigate the high pressure of the primary propulsive charge. The explosive payload of the grenade is limited by: (1) the diameter of the cartridge, (2) the significant non-lethal overhead of the fuzing assembly, (3) the limitation on amount of propulsive charge available to achieve the desired range, and (4) and the volume reserved for high/low pressure cavities. The result is that prior art 40 mm grenades are often limited to an explosive payload and shrapnel casing that is approximately the size of a large jawbreaker. This size limitation reduces its efficiency dramatically—for example, a standard M67 hand-thrown grenade in use in the US military has an effective casualty radius of 15 meters, while 40 mm grenades such as the M406 have a limited casualty radius of only 2.5 to 5 meters.

[0048] New technology has also not improved the explosive yield of launched grenades. In a more recent design, the prior art Alliant Techsystems / Heckler-Koch XM-29 SABR / Objective Individual Combat Weapon (OICW) assault rifle (see FIG. V1f)

incorporates a 20 mm grenade launcher into a combined infantry weapon. New variants of this weapon may use a slightly larger 25 mm grenade. Although the 20 mm grenade (see FIG. V1g) is capable of either an impact or air-burst detonation, this small, lipstick tube-sized ordinance still fails to provide a significant effective casualty radius compared to hand-thrown grenades. What is needed is a grenade that has an improved payload to overhead volume, allowing a detonated launched grenade to approach or exceed the casualty radius of a hand-thrown grenade. What is further needed is a means for propelling a larger grenade that does not impart substantial recoil to the firing soldier.

[0049] The Portable, Free-Recoil Automatic Grenade Launcher (P-FRAG-L) and Enhanced-Yield Rocket Grenade (ERG) of the present invention comprise a number of improvements over prior art grenade launchers. The propulsion and ignition system of the present invention is derived in part from the Gyrojet rockets, Gyrojet rocket pistols, and Gyorojet carbines developed in the 1960's and 1970's and described in *The Small Arms Review*, Vol 5 No. 10, July, 2002; and in U.S. Patent Numbers 3,212,402 ("Hand Weapon"); 3,412,641 ("Pistol For Firing a Miniature Ballistic Rocket"); 3,367,112 ("Multiple Plate Rocket Nozzle"); 3,367,113 ("Internal Cut Rocket Nozzle"); 3,419,230 ("Nozzle"); 3,490,121 ("Method of Making a Rocket Nozzle"); and 4,002,122 ("MicroJet Fuse"); the disclosures of which are incorporated by reference herein for all purposes.

[0050] Similar to Gyrojet rockets, the grenade of the present invention comprises a sealed round without a separable cartridge casing that uses burning propellant or fuel to produce a high-speed jet output from nozzles on the rear of the cartridge, with forces created thereby to propel the cartridge forward. Likewise, the grenade of the present invention further comprises canted, angular, or asymmetrical exhaust nozzles on the rear/bottom of the grenade

cartridge whereby escaping gases impart torque forces on the grenade with respect to its central axis, thus producing spin-stabilized flight (see, e.g., U.S. Patent No. 3,490,191 FIG. 8 and FIG. 4, and U.S. Patent No. 3,367,112 FIGs. 1-4.). There are numerous advantages that arise from using such a propulsion system for a launchable grenade, among which are a simplified operating system, a single-piece round that does not leave behind a spent cartridge casing that must be ejected, a quieter propulsion system than those provided by prior art launched grenades, substantially reduced or negligible recoil, and the ability to shoulder-fire weapons that launch grenades of such mass that would produce unmanageable or dangerous recoil if fired from a traditional shoulder-fired explosive-gas propulsion launcher. However, in a major departure from the prior art Gyrojet rockets, the grenade of present invention further comprises a payload with an arming/fuzing assembly that provides for a high explosive blast with shrapnel, smoke clouds, flares or shape-charged armor-piercing ordinance.

[0051] Referring to FIG. V1h, an illustrative example of one embodiment of the present grenade invention is shown in cross section. Like Gyrojet rounds, the grenade (V1m11) comprises a sealed Housing, and further comprises a Primer that ignites a Propellant. The Propellant produces a gas that is expelled from Nozzles disposed on the rear of the grenade, that provide forward (in the direction of the Ogive) and rotational (with respect to the central axis) forces to propel the grenade toward its target and provide spin stabilization during flight. In the illustrated embodiment, the propellant is sealed in a cavity at the bottom of the grenade (the Propulsion Section) rather than disposed substantially along the central axis of the grenade as in the Gyrojet rockets, allowing for a more flexible payload configuration. Alternatively, the Propellant could be placed in a hollow cylinder format much like prior art Gyrojet rockets, and such propellant would surround, at least in part, the Payload Section. The shown Payload

Section comprises a cylindrical section of explosive surrounded by a frangible (optionally pre-segmented) metal Grenade Casing, that upon explosion provides shrapnel to enhance the casualty efficacy. Disposed centrally to the Explosive is a Detonator that is triggered by an Arming/Fuzing Assembly upon the grenade reaching a target or proximity condition. Optionally, the fire control system of the present invention's grenade launcher (discussed below) may transmit to the Arming/Fuzing Assembly data via an RF or contact connection to modify or preprogram detonation conditions. The Arming/Fuzing assembly arms the grenade after a predetermined number of rotations after being fired, or through a certain angular velocity or moment being reached, or through a time delay mechanism after firing or some combination of the above. A Sensor Assembly comprises instruments that detect targeting and proximity conditions and transmit those signals to the Arming/Fuzing Assembly, comprising instruments such as a laser reflection sensor, forward and/or side-looking RF transmission and reflection sensor, a time of flight sensor, an impact sensor, and/or an impact plus delay sensor. The Ogive may be constructed of metal or durable optic- and/or RF-transparent material that would enable the Sensor Assembly to gain target information during flight. Optionally, the Sensor Assembly and Arming/Fuzing Assembly may be enclosed in an encapsulant such as epoxy to provide further durability. The nozzle and primer/ignition design at the base/bottom of the present grenade invention (shown with circular canted orifices in FIG V1i and rectangular offset orifices in Fig F1j) may follow any number of prior Gyrojet implementations, including those illustrated in the abovementioned patents and FIG. V1k. The embodiment illustrated in FIG. V1h in no way limits specific design features of the present invention that are not shown in the figure but are disclosed in any of the incorporated references.

[0052] While prior art launched grenades are usually 20 mm or 40 mm in diameter, the present invention may be scaled to any practical dimension, and in one preferred embodiment, the diameter of the present invention rocket grenade is 60 mm, with an Ogive to Base length of 135 to 200 mm. Such dimensions will support a very substantial explosive payload, approaching or exceeding grenades or mortar shells. While the illustrated grenade embodiment shows an explosive payload, the Payload Section may also be equipped with a wide variety of functional elements such as a canopy smoke generator, a flare with parachute, an infrared beacon for bomb targeting, a white phosphorous payload with explosive dispersant, a copper-coned armor-piercing shaped-charge explosive (such as the common HEAT round), a non-lethal percussion round to stun persons in a localized target area, or a tear gas/pepper gas round.

[0053] The automatic grenade launcher of the present invention is illustrated in FIG. V1m and uses an operating system similar to the Gyroget pistol disclosed in U.S. Patent Nos. 3,412,641 and 3,412,402, incorporating features of those disclosures as necessary for the operation of the invention. The grenade launcher (V1m1) is comprised of a buttstock assembly (V1m2); a receiver group (V1m3) with fixed firing pin (V1m7) and hammer (V1m9) and trigger and grip assembly (V1m10); a forestock assembly with integrated fire control system (V1m4); a range-targeting/sight/elevation assembly (not shown); a barrel (V1m5); a laser rangefinder and target illuminator (V1m6); and a spring-loaded removable grenade magazine (V1m8) that is capable of storing and feeding a plurality of rocket grenades (V1m11).

[0054] A typical firing sequence of the grenade launcher of the present invention is illustrated in FIGs. V2a-V2g. Referring to the terminology discussed above in relation to FIGs. V1h, V1i, V1j, and V1m, we turn to FIG. V2a, wherein the launcher is loaded and in a ready-to-fire state. In FIG. V2b, a trigger pull causes the hammer (V1m9) to begin swinging back

toward the ogive of the grenade (V1m11), and in FIG V2c, the hammer (V1m9) makes contact with the grenade (V1m11). Next, in FIG. V2d, a spring (not shown) that holds grenade (V1m11) in its battery-ready position is compressed as the force from the hammer is imparted to the grenade and drives the grenade toward the buttstock (V1m2). The grenade's (V1m11) rearward motion ultimately causes the grenade's primer to impinge on the fixed firing pin (V1m7), resulting in ignition of the grenade's rocket propellant. Note that grenade (V1m11) is not armed until fired and downrange, and is equipped with an ogive that is capable of withstanding the force of the hammer without damaging or prematurely detonating the grenade. It is appreciated by those of skill in the art that in an alternate embodiment, a conventional spring-loaded firing pin could be used in place of the backwards-striking hammer and fixed firing pin of the present embodiment. In another embodiment, the launcher further comprises a positive safety mechanism that when in safe mode places a metal arm (not shown) between the chambered grenade (V1m11) and the fixed firing pin (V1m7) preventing any rear motion even upon the launcher being dropped vertically onto its buttstock. Next, in FIG. V2e, the grenade's (V1m11) rocket propulsion operates to propel the grenade forward down the barrel (V1m5) and to impart a spin to provide gyroscopic stabilization of the grenade as it progresses downrange to target. Immediately after its contact with the grenade (V1m11), the hammer (V1m9) begins its return to the battery ready position, simultaneously clearing a path for the grenade (V1m11) to progress down the barrel (V1m5). FIG. V2f illustrates the grenade (V1m11) accelerating down the barrel (V1m7) as the hammer (V1m9) has returned to its battery-ready position, and the launcher starts to a accept another grenade that is fed from the spring-loaded magazine (V1m8) into the receiver group (V1m3). Once the next unfired grenade has been fed into the battery-ready position, the grenade launcher is ready to fire again, as is shown in FIG. V2g. Those of

skill in the art appreciate that such an operating system could be readily adapted to fire in semi-automatic mode, full-automatic mode, or burst mode, or any of such modes that may be selected by the soldier firing the rifle through the actuation of a selector switch.

[0055] FIGURES V3a-j illustrate targeting and downrange operation of the grenade launcher of the present invention. One advantage of the present invention is that unlike many prior art grenade launchers, a soldier may be lying behind cover with the grenade launcher near the ground, and the soldier is able to rapidly deploy a large number of grenades from a magazine without the need to expose himself from cover. Referring to the terminology discussed above in relation to FIGs. V1h, V1i, V1j, and V1m, we turn to FIG. V3a, wherein a solider is lying behind cover, and has targeted approaching enemies. In FIG. V3b, an enemy who is only partially exposed downrange (for instance, the enemy may be in a foxhole or behind a ridge, and may only be in line of sight periodically) is targeted by the launcher's laser rangefinder. In the targeting mode disclosed in FIGs. V3a-h, the launcher and grenade of the present invention are configured to achieve an air burst over the head of the partially or completely obscured enemy, thereby creating casualties even to those lying on the bottom of a deep foxhole, such air-burst mode selectable by the solider firing the launcher through use of a switch or other mechanism, not shown. In this mode, the laser range finder/target illuminator (V1m6) is activated, and the fire control system in the launcher (V1m1) provides a visual indicator instructing the soldier to elevate the rifle to achieve the proper target range. The fire control computer further comprises an elevation sensor and correct elevation indicator, so that when the launcher (V1m1) has been inclined to the proper elevation, an indicia is provided to the soldier that the launcher is ready to fire. Then after firing, the grenade (V1m11) proceeds downrange toward the target, in one mode having been preprogrammed by the fire control

system to detonate at a certain elapsed time after being fired, such time calculated from the range data received by the laser targeting, and the known performance flight information of the round. In a second mode, the sensor assembly of the grenade (V1m11) tracks the reflected energy of the laser designator (V1m6) currently painting the target area, and when a rapid drop off in reflected laser energy occurs, or upon impact, whichever comes first, the fuzing mechanism of the grenade operates to cause the grenade to detonate. In a third mode, a side-looking RF reflection monitor (radar) detects a rapid fall-off in distance to signal, indicating the grenade has passed over an opening in the ground such as a foxhole, and as a result, the sensor sends a signal to the fuze to detonate the round. Any of these targeting modes would be sufficient to cause the grenade round to detonate in the air above the heads of hunkered-down enemies, resulting in a single burst that is highly effective at neutralizing dug-in personnel. FIG V3b illustrates the elevated launcher firing a round, its jet operating to move the grenade in an arc downrange toward target (note the white circular cloud of the jet exhaust) while the target is illuminated by the laser (V1m6). FIG. V3c shows the grenade nearing the overhead position of the enemy, whereupon it detonates and neutralizes the enemy. FIGs. V3e-g illustrates that the launcher and grenade of the present invention may be targeted in such a manner as to provide an area effect blast to neutralize several targets simultaneously, by targeting a region between two or more threats. FIGs. V3h and V3i illustrate another mode of the launcher and grenade of the present invention whereby the launcher is used in a standard ballistic targeting manner without the actuation of the laser rangefinder, wherein the impact or proximity fuze of the grenade detonates the grenade's explosive when the grenade has reached and impacted its target (or, alternatively, is within a predetermined proximal range of a target, such as within one meter of a solid object). FIG. V3j illustrates the rangefinder determining

distance to target (here, shown 620 feet), and programming the grenade round to detonate after a time period sufficient to place the grenade 620 feet downrange, and thereby detonate near the target.

Recon Bird and Ground Control Station

[0056] The Recon Bird of the present invention extends the eyes of the infantry above the limited battlefield line of sight and provides a means to identify, target, and designate enemy weapons systems from positions concealed from the enemy's view. In essence, the Recon Bird system provides the infantry soldier the ability to see over mountains and ridges from the safety of a foxhole, and to fire and guide missiles in an anti-armor or anti-aircraft mission without the need for downfield COLT or forward observer teams.

[0057] Small, portable, prior-art unmanned aerial vehicles (UAVs) have begun finding applications in military reconnaissance missions. For example, the Dragon Eye UAV from AeroVironment (see FIG. Q1a) presently in use by the U.S. Marine Corps is a small (48-inch wingspan), lightweight (about 5.5 pounds) battery-powered propeller-driven fixed-wing aircraft that provides the user with the ability to obtain real-time video of surrounding terrain that may not be viewable from a soldier's present line of sight. The Dragon Eye's fuselage-mounted side-looking sensor comprises a low-light black and white camera, capable of transmitting live video to the soldier's ground station from a distance of 10 km, via line-of-sight video datalink. However, the Dragon Eye is not without limitations. For instance, the operator must monitor Dragon Eye's cameras through "video goggles" connected to a laptop computer. Likewise, Dragon Eye's mission duration is less than 60 minutes of flight time, and its maximum range is only about 3 miles from the operator. The Dragon Eye's flight path is not controlled actively

by the operator, but instead pre-programmed before its launch. Further, the pre-programmed flight path waypoints are traversed via GPS guidance, which, unfortunately may be susceptible to jamming under battlefield conditions.

[0058] Other UAV's such as the AeroVironment Raven (FIG Q1b), have been developed to add additional mission capacity time. The Raven has a mission endurance of 80 minutes, and is controlled by an operator with two joysticks and an array of buttons. However, the larger sized Raven platform requires two soldiers to carry the entire system, and like all fixed-wing aircraft, the Raven must maintain forward velocity (and therefore be constantly moving) to maintain flight. What is needed is a small, man-portable UAV that can provide a real-time video image to a soldier, while the soldier is able to control the UAV's flight. What is further needed is a UAV that is capable of vertical takeoff and automatic hovering, providing station keeping with the operator on the ground below, so that the UAV can "follow" the operator if the operator is required to move. What is further needed is the ability to laser designate a target in either a coded reflected-energy method (such as with a portable MULE device) or with a low-power laser beam path for beam-riding missiles. What is further needed is a small and portable UAV with millimeter-wave radar for sensing and painting targets, with a feed to a ground station for missile guidance and tracking. What is further needed is a small and portable UAV with infrared or thermal imaging that is relayed to a ground station.

[0059] One embodiment of the Recon Bird of the present invention is illustrated in FIG. Q1c. The Recon Bird (Q1c10) is comprised of a fuselage (Q1c1) with two detachable wings (Q1c2); a detachable vertical stabilizer (Q1c3); two detachable horizontal stabilizers (Q1c4); two electrically-powered, rotatable, detachable, engine nacelles (Q1c5); a sensor/illuminator/radar pod (Q1c6); and a flight control and ground link system (not shown).

For portability, the Recon Bird (Q1c10) may be stored disassembled in its component parts (see FIG Q1d., Q1c1), protected from damage and environmental exposure by an optional container (FIG. Q1d., Q1d1), and then may be hand-assembled without tools by the field operator when needed for deployment. The Recon Bird (Q1c10) is constructed preferably from lightweight composites, and in one embodiment, comprises a wingspan of approximately three feet. Stealth technologies are designed into the preferred embodiment, with the lightweight composites designed to reflect a minimum radar cross-section, and may optionally comprise radar absorptive cavities and coatings. Between the design topology, small radar cross-section, and radar absorptive/reflective features, the Recon Bird (Q1c10) presents a very low likelihood of detection by conventional radar.

[0060] After assembly in the field, the operator deploys the Recon Bird (Q1c10) through providing instructions via a field navigation and visualization panel that flips down on the operator's chest (not shown). The operator commands the Recon Bird's engines to start, and provides a desired hover altitude and bearing. The Recon Bird, like the V-22 Osprey, is capable of rotating its engine nacelles to provide for a vertical thrust vector, and takes off with no forward velocity required (unlike prior art UAV's such as Dragon Eye and Raven, which must be thrown forward to launch by a bungee-like device). The Recon Bird (Q1c10) establishes a link with the ground operator or Personal Carrier, and then provides electrical power to its propeller motors, causing the Recon Bird to climb to and maintain an altitude as commanded by the ground operator. While the Recon Bird provides for stealthy, low-altitude reconnaissance, it also has a service ceiling of approximately 10,000 feet above ground level depending on the specific engine configuration. The Recon Bird is capable of manipulating its rotatable engine nacelles (Q1c5) to maintain station (hover) over a designated point, or if the

operator must move, the Recon Bird may be configured into an automatic follow mode to change its position relative to the operator's movement on the ground. In this manner, the operator can maintain communication with the Recon Bird even if the circumstances warrant a sudden change of position.

[0061] The Recon Bird's rotatable nacelles (Q1c5) provide for a station-keeping hover mode, but also allow for a planned reconnaissance or loitering mission where a manually-controlled or pre-programmed patrol path is downloaded into the Recon Bird's guidance and navigation computer. In this mode, the Bird uses its nacelles in a forward position to provide forward thrust to support airfoil lift, allowing the bird to scout a larger expanse of terrain in a shorter period of time than rotary-wing flight mode might allow.

[0062] Once airborne, the sensor pod (Q1c6) of the Recon Bird begins to relay images to the operator's chest display, either via an RF link such as UHF, LPI (Low Probability of Intercept) spread-spectrum, or through a tethered wired or optical fiber link. In one embodiment, the Recon Bird may be tethered to or establish an RF link with the Personal Carrier of the present invention or a tactical missile that is stored within the Personal Carrier. In an embodiment using a wired tether, the Recon Bird receives additional power through the wired link to increase its mission flight time, such power being provided by a ground-based energy source such as a battery pack, solar panel, or generator located in the Personal Carrier.

[0063] The sensor pod (Q1c6) provides a variety of information to the operator, based on the sensor mode selected at the operator's control station. The Recon Bird is capable of providing real-time low-light color or black and white imaging, starlight imaging, or infrared and/or thermal imaging video data to the operator's display panel. Through manipulating controls, the operator can instruct the hovering Recon Bird to change bearing and/or point its

cameras/sensors at a fixed area of terrain, and zoom in on specific features or weapons in place by armor. The Recon Bird (Q1c10) further comprises navigation equipment such as GPS or inertial guidance equipment so that the drone can determine its position and bearing and relay the position, bearing, and range data to the operator, ground station, or Personal Carrier.

[0064] Once the operator has determined that an object of interest in his viewfinder requires targeting, the operator manipulates a crosshair image on the display through a joystick or touch panel, and actuates a control that indicates the object under the crosshair is to be locked onto as a target. The Recon Bird then transmits this information to its guidance computers, determines and downlinks range, bearing, and target information and maintains station-keeping for potential target designation. In one embodiment, the operator may then provide a fire command to a tactical missile such as the missile of the present invention, and at the appropriate time, the Recon Bird illuminates the designated target with a coded laser beam for reflected energy guidance or for beam-riding information to provide terminal guidance for the missile to reach the selected target. In an alternate embodiment, the Recon Bird's MMW radar identifies the target that was visually locked, provides range, bearing, and radar coordination information via downlink to the tactical missile system, and after the fired missile achieves lock with the designated target, the Recon Bird turns off its radar system.

[0065] While a preferred embodiment of the Recon Bird was shown and described, alternate embodiments may be utilized within the spirit of the invention. For example, the propulsion system and airframe used in the above embodiments (V-22 Osprey-style rotatable nacelles) may be replaced by alternate flight platforms such as the conceptual Mesicopters shown in FIGs. Q1e and Q1f. While the Mesicopters illustrated are intended for very small-scale applications (such as having a total span of only 1cm), the bodies of these rotary wing

aircraft may be scaled to any size necessary, including up to a size large enough to support an embodiment of the sensor pod (Q1c6).

Tactical Missile System

[0066] One advantage NICWS provides is the force multiplication that results from every individual infantryman having available man-portable anti-aircraft anti-armor tactical missiles. In conjunction with the Personal Carrier and Recon Bird embodiments of the NICWS system, each soldier in an army now has the power to deploy standoff missiles to destroy armor or aircraft, without direct line of sight, from a safe cover point that may be physically removed from the missile launch site. Further, when infantry are dispersed in the field by a significant distance, and physically removed from a missile launch site, the army as a whole is rendered far less vulnerable to area attacks since only one or perhaps a few soldiers at a time (not an entire platoon) are subjected to injury from area weapons such as artillery or mortar fire.

[0067] By way of background, prior art man-portable tactical missiles such as TOW missiles (see FIG. U3a) suffer from a number of shortcomings. For example, many prior art missiles are bulky and difficult for troops to carry, reducing the number of missiles that can effectively be field-deployed. Further, since some prior art missiles are guided by SACLOS (Semi-Automatic Command to Line-Of-Sight) guidance systems, soldiers firing these prior-art tactical missiles must maintain a line of sight from their firing positions and in an exposed posture while guiding the fired missile downrange to its target. The exposure from guiding prior art missiles renders infantry susceptible to attack and the direct line of sight requirement prevents troops from firing missiles from a safe position (for instance, from behind a ridge).

[0068] Other non-man-portable prior-art tactical missiles such as the AGM-114 Hellfire (HELicopter-Launched FIRE-and-forget missile) missile system (see FIG. U3b, U3c) have the capability of being fired from platforms that do not have direct line of sight to the target, such as behind a copse of trees or behind a mountain range, but require the target to be continually identified by a solder using laser-designation. A ground designation station such as a forward observer or Combat Observation Lasing Team (COLT) accomplishes this with lasing devices such as the G/VLLD or MULE. While this mode provides the ability for the weapon platform to fire while in a defensive posture, a laser-designation operator is still required to be within line-of-sight to the target. Improvements to the AGM-114 missile such as a millimeter-wave radar fire-control system precludes the need for a forward observer or COLT team, but the prior art missiles are often still too bulky or heavy to be man-portable (e.g. over 100 lbs for the Hellfire missile alone, without launch platform or fire control radar system).

[0069] Some other prior-art tactical missiles such as Javelin use a fire-and-forget infrared guidance system. However, these systems still require an initial line of sight to the target for the gunner to obtain a lock-on-before-launch condition so that the missile can be fired and then assume infrared guidance to its target. Javelin missiles, though an improvement, still place the gunners in somewhat precarious conditions by requiring an extended period of time for missile lock while under line of sight conditions, and are further hampered by limited range. What is needed is a tactical missile that is field-deployable by infantry troops and that is capable of destroying airborne or land-based armored targets. What is further needed is a missile system that can overcome perimeter defense systems or reactive armor. What is also needed is a tactical missile system that can be fired at a physical location that is physically removed from the person firing the missile. What is also needed is a high-speed, lightweight,

portable missile system that can strike targets that are not within line of sight at time of firing, and that do not require additional troops to designate targets downrange.

[0070] The improved tactical missile system of the present invention provides an improved multi-role missile system that can shoot down aircraft as well as destroy armor units, even when armor units employ sophisticated anti-missile defense systems such as reactive armor coupled with stand-off perimeter defenses. One embodiment of the present invention and a method of its deployment are illustrated in FIGs. U1a-U1l. Turning to FIG. U1a, the illustrated present invention missile is shown. The tactical missile of the present invention is based on an improved design to the Shorts Missile Systems (SMS) Starstreak missile currently fielded by the United Kingdom and under test in the United States. While the prior-art Starstreak was initially designed for an anti-aircraft role, reports indicate that the Starstreak missile has been effectively tested in penetrating over a meter of rolled homogeneous armor (RHA) plating, potentially making the missile effective against any conventional mechanized armor in use today.

[0071] The missile of the present invention (U1a1) is composed of a forward end with seeker/standoff head (U1a5) a main engine/propulsion/guidance/fuzing/ordinance section (U1a4), a soft launch propulsion first stage (U1a3) at the rear of the missile, deployable fins (U1a5) that actuate after launch, and a plurality of darts (U1a2) that are detachably attached to the forward end of the main section (U1a4). At the rear of the main body (U1a4), an optional number of laser beam-riding sensors are disposed so as to receive laser tracking indicia from the firing/sighting platform and provide signals to the guidance section.

[0072] The present embodiment of the assembled Starstreak missile (upon which the tactical missile of the present invention (U1a1) is based) measures approximately 55 inches

long, five inches in diameter, weighs approximately 45 pounds, and with a top speed approaching Mach 4, has a range of approximately 300 yards to over 4.3 miles. Those of skill in the art recognize that the Starstreak design may be modified (as in the present invention) to have an extended range through a longer-burning and/or higher thrust main engine. The present invention also incorporates advanced seeker sensor circuitry into the seeker/standoff head (U1a5) including options for active millimeter wave radar, reflected laser radiation guidance, long-wave infrared guidance, or multi-mode guidance. In addition, the present invention also incorporates an additional optional explosive shape-charged ordinance and fuzing assembly in the main section (U1a4) (such as used with the Hellfire missile system shown in FIG. U3c) along with an optional tandem warhead in the standoff head (U1a5) to add additional capability to defeat explosive reactive armor. Those of skill in the art also recognize that while the embodiment shown in FIG. U1a comprises three darts, it may be desirable to use fewer or more darts attached to the forward end of the missile (U1a1).

[0073] A dart of the present invention (U1a2) is shown in more detail in FIG. U1b. The dart (U1a2) comprises clipped-delta rear fins (U1b1) at the aft or rear section of the dart body (U1b3) and forward canard fins (U1b2) disposed along on the outside of the forward end of the dart (U1a2). The head or nose cone (U1b4) of the dart is attached to the forward section of the dart body (U1b3) and in one embodiment, comprises solid hardened metal such as tungsten or depleted uranium. In an alternate embodiment, the dart head (U1b4) comprises an electronics seeker head that is integrated to a control/guidance system located in the dart body (U1b3). The dart (U1a2) optionally comprises sensors disposed along the rear of the dart near the fins (U1b1) that receive guidance information from the targeting device, and relay such information such as laser beam-riding indicia to the dart's guidance system. The dart's

guidance system operates actuators connected to the fins (U1b1) and forward canards (U1b2) to provide terminal guidance to the target after the dart (U1a2) has separated or been launched from the main missile body (U1a4). While the embodiments illustrated in FIGs. U1d-U1j illustrate the darts (U1a2) having propulsion through rocket motors contained within the dart bodies, those of skill in the art also realize that such darts may be propelled only in glide mode through the kinetic energy delivered by the main propulsive rocket motor in the main body U1a4. In such a glide-mode embodiment, darts U1a2 are equipped with guidance circuitry, fuzing mechanisms and explosive ordinance, but after being deployed by the main missile body U1a4, simply glide into the target by the velocity imparted to them by the main missile. Alternatively, if a dart's engine reached maximum range and burnout, the glide mode could continue to direct the dart to target through its accumulated kinetic energy.

[0074] The dart (U1a2) of the present invention is equipped with an explosive charge that comprises any one of conventional anti-armor or anti-aircraft ordinances such as single or tandem HEAT (High-Energy Anti-Tank) warheads, or blast/fragmentation warheads, or a combination HEAT/blast fragmentation warhead. On impact, or through signals related proximity circuitry in the head (U1b4) of the dart, the fuzing assembly located in the body (U1b3) of the dart (U1a2) provides a detonation signal to the warhead contained within the dart body (U1b3), thus providing the charge to destroy the target. It is also noted that the kinetic energy imparted by the high-speed dart (U1a2) can inflict significant damage to the target, even if no explosive warhead is included. Through the use of a high cross-sectional density nose (such as refractory depleted Uranium) and hardened metal body, one embodiment of the dart provides kinetic armor piercing capability not unlike conventional anti-armor sabot rounds.

[0075] Turning now to FIG. U1c and subsequent Figures, the missile of the present invention (U1a1) is illustrated in its firing and deployment to a target (U1g1). In one embodiment, the missile of the present invention may be fired from a personal carrier such as described herein or shoulder fired from a tube launcher. FIG. U1m and U1n illustrate the launch of such a missile from the personal carrier disclosed herein. Immediately upon receiving the firing signal, the first stage motor (U1a3) fires to impart initial forward motion to the missile (U1a1) and shortly after the missile leaves its tube (see, e.g., FIG U1n) in a forward direction (U1c2), the fins (U1a5) hingedly open to a substantially perpendicular position from their storage position against the body of the missile, and the missile body (U1a4) separates (U1c1) from the first stage (U1a3). Immediately after separation, the main missile propulsion engine ignites (FIG. U1d) and after the missile accelerates towards its target, at a time determined in part by remaining distance to target, a first dart (U1d2) separates from the main missile body (U1a4). It is appreciated by those of skill in the art that the main missile's rocket motors may still be operating at such separation time, or may have burned out during the first or subsequent dart separation sequence. If the previously-described dart glide mode embodiment is utilized, for instance, dart separation may not occur until the main rocket engine has burned out or shut off through internal commands from its guidance system.

[0076] Continuing with FIGs. U1d through U1f, the present invention provides an improvement not incorporated in prior art missiles, namely, a phased release of the darts U1a2a-U1a2c from the main missile body U1a4. In the prior art Starstreak system, for instance, all darts are released from the rocket body substantially simultaneously. In the present invention, however, a delay is utilized in releasing the darts so that the darts fly a spatially-diverse trajectory toward the target (U1g1). Put another way, the darts U1a2a-U1a2c are

released from the main missile in a manner that imparts a substantial delay between their respective impacts on the target U1g1. The advantage of this special diversity becomes more apparent when considering the defensive systems being used in modern armor.

[0077] Explosive reactive armor (ERA) has been adopted by a number of armies and incorporated into mobile armor platforms. Reactive armors utilize protection modules comprising thin metal plates and sloped explosive sheaths, which explode upon sensing an impact of an explosive charge (such as a HEAT projectile). The repulsive explosion of the reactive armor significantly diffuses the plasma jet created from the shaped charge warhead as it penetrates the armor, reducing or eliminating its penetration into the protected cavities of the target. Some recent improvements to reactive armor even provide some protection against kinetic energy rounds.

[0078] To defeat reactive armor, modern anti-armor missiles such as the Hellfire often employ tandem warheads whereby an initial explosion detonates the reactive armor, clearing a path for a second more powerful warhead to attack the main armor. While fairly effective against reactive armor, tandem warheads may be rendered inert when engaged by modern perimeter defense systems such as FCLAS.

[0079] Turning to FIG. U3d, the prior art FCLAS (Full Spectrum Active Protection Close-In Shield) "grenade" is shown. The grenade comprises a gunpowder explosive propulsion chamber to launch the round from a tube mounted on the mobile armor vehicle, a shaped charge that fires a cylindrical "cloud" of shrapnel radially outward from the central axis of the grenade, a forward-looking radar sensor that detects an incoming threat, and side-scan radar sensors that detect horizontal proximity to an incoming threat target. Once the forward looking radar determines that a threat such as an anti-tank missile is approaching the vehicle, it

fires the propulsive charge, to launch the FCLAS grenade in the direction of the incoming threat. When the side-scan radar sensors determine that the grenade has achieved proximity to the threat, the FCLAS grenade detonates, thus destroying the threat before it has a chance to impact the vehicle. Such rounds can be placed in various orientations on a vehicle to provide a "shield" effect (see FIG. U3e) against incoming missiles.

[0080] The missile of the present invention has the ability to successfully attack a vehicle equipped with both reactive armor and a perimeter defense such as FCLAS. In a method of the present invention, darts (U1a2a, U1a2b, and U1a2c) are progressively launched from the main missile (U1a4) as depicted in FIGs. U1d-U1f, producing a serial cluster of darts to attack the target U1g1 (see FIG U1g). A first dart (U1a2a), other darts, or the main missile body (U1a4) may trigger a perimeter defense such as the FCLAS grenade (U1g2) to deploy from its launcher, and the first dart (U1a2) when detected by the FCLAS grenade radar, may be destroyed by the FCLAS in the process (FIG. U1h, U1h1). However two darts (U1a2c and U1a2b) that were fired from the missile survive because they had been launched in a delayed fashion, and continue to approach the target and as shown in FIG. U1j. FIG. U1i illustrates a second dart (U1a2b) impacting with the vehicle U1g1, potentially detonating explosive reactive armor (U1i1) attached to the vehicle U1g1. As FIGs U1i and U1j illustrate, a third dart (U1a2c) still approaches the target, and with the perimeter defenses and reactive armor countermeasures now cleared, is free to inflict damage (U1j1) on the vehicle (U1g1). Those of skill in the art also recognize that the first dart may impact the target initially, with a second or subsequent dart or missile triggering the FCLAS grenade.

[0081] In another embodiment, the missile of the present invention (U1a1) possesses independent guidance circuitry and a warhead that allows for it to deliver a significant

additional blow to the targeted vehicle (U1g1) after darts (U1a2a, U1a2b, and U1a2c) have already impacted and optionally suppressed the vehicle's defenses. Turning to FIG. U1k, the main missile section (U1a4) approaches the target (U1g1) after having deployed its darts. Using the sensors and guidance approaches described above, the section (U1a4) impacts with target (U1g1), providing for additional destructive and lethal effect of the attack. Since the vehicle is likely stripped of its active defenses by the phased dart attack, the resulting effect is likely total and complete devastation of the remainder of target vehicle.

[0082] The missile of the present invention provides for a staged attack on a vehicle that serves to clear and suppress vehicle defensive systems. However, if no such defensive systems were used by the target vehicle, the darts and missile body provide multiple strikes to enhance effectiveness of the invention against armored targets. In addition to ground targets, the missile of the present invention is also capable of striking airborne targets, and in the section that follows, a number of guidance modes are discussed that present alternative scenarios for missile deployment. Those of skill in the art also appreciate that alternative non-dart-based missiles such as the Hellfire could be launched by the Personal Carrier and utilized in remote engagement with either armored ground targets or potentially in anti-aircraft scenarios.

[0083] In yet another embodiment, the missile of the present invention comprises a plurality of explosive shells located in its forward nose, the shells containing a primary explosive propellant and kinetic kill payloads such as depleted uranium (DU) rounds. In one particular configuration, the nose code of a missile such as the HELLFIRE missile is adapted to contain a plurality of the forward DU-explosive shells, and as the missile approaches the target, at a distance such as 30 meters before impact, the missile fires the shells, for example three

independent rounds, at the target. Like the darts (U1a2a, U1a2b, and U1a2c) of the present invention, these DU rounds act to suppress defense measures by assisting in defeating reactive armor and FCLAS-like perimeter defenses, but are also intended to inflict severe damage to the primary target. The main missile system that delivered the DU rounds, if it survives the perimeter defenses, then impacts on the target and delivers its explosive warhead. In an additional embodiment, the DU shells are progressively fired in a timed-delay sequence so that the earliest rounds fired have a high likelihood of acting individually to suppress perimeter defenses and reactive armor while the later fired rounds are then clear to inflict damage on the primary target. In yet another embodiment, rather than firing DU shells, as the missile of the present invention approaches the target, it fires a volley (either spread through time or simultaneously) of explosive grenades that further comprise proximity sensors. Therefore, when the volley of explosive grenades reach a predetermined proximity to a target or a defensive device such as an FCLAS grenade, they detonate, causing the defensive device or target to be destroyed and clearing the way for an unmolested attack from the main missile.

[0084] Another advantage of the present invention is its ability to deliver a missile in a variety of different guidance mode scenarios. The present invention may use the SACLOS-type (Semi-Automatic Command to Line-Of-Sight) guidance mode that has been implemented in the current Starstreak missile and in other prior art missiles such as the TOW missile. In the missile of the present invention's SACLOS mode, the soldier activates a laser designator (such as one that is in communication with the personal carrier weapons control system) and paints the target that is desired to be destroyed. After commanding the tactical missile to fire, the missile launches into the air and acquires the laser beam's signal, and follows the laser beam to the target through beam riding techniques (or alternatively or in combination, through tracking

reflected laser energy from the target). This way, the present invention's tactical missile can provide SACLOS guidance to quickly destroy a target that is directly in line of sight.

[0085] The present invention's tactical missile also supports a fire-before-lock SACLOS mode for remote engagements, whereby the missile's tracking control system is provided bearing and range to target information while a forward observer laser designates the target. In another embodiment, the target may be lased not by a forward observer, but a by the recond bird of the present invention. By waiting for laser designation until after the missile is fired, the likelihood is reduced that the target may detect that it is being painted by a laser for reflected energy or beam-riding tracking. After the missile is fired, its range and bearing data is used to steer the missile initially toward the target, and if an obstruction such as a mountain range is between the launch platform and the target, the missile is instructed to climb to a clear altitude before beginning seeking for laser information. In one embodiment, where the target is to be designated by the recon bird of the present invention, the tactical missile uses the ranging data furnished by the recon bird to determine the location of the recon bird, and then after being fired, gains altitude and heads generally in the direction of the bird before nosing over and pointing in the direction of the target. In this way, the tactical missile of the present invention may acquire lock to the recon bird's laser targeting beam more quickly, and the recon bird (or forward observing team, for that matter) can wait to designate the target until the last few seconds of the missile's trajectory, thus reducing the likelihood of alerting the target that it is about to be destroyed.

[0086] In yet another embodiment of the tactical missile of the present invention, a synchronized fire-and-forget mode is provided. In this guidance mode, the missile is provided with general range and bearing to target information, such as by data downlinked to its

navigation and control system by the recon bird of the present invention, through a soldier's individual target tracking system, through map coordinates, or from a integrated logistics system such as J-STARS that is linked to the soldier's tactical display. Once the bearing and ranging information is provided to the tactical missile, mission flight profile information is further provided so that a proper flight path can be chosen to overcome obstacles such as mountain ranges, etc. Once the data and flight profile is provided to the tactical missile, the missile is fired and assumes the specified flight profile. Using its navigation system (inertial, GPS, a combination, or other similar methods) the missile then gains altitude and begins active tracking for a target using millimeter-wave (MMW) radar, long-wave infrared, or a combination of the two approaches to select the target to be destroyed. In one embodiment, the recon bird of the present invention provides target acquisition data with its own active MMW unit so that the tactical missile may align its own radar and guidance system with the target range information.

[0087] In yet another guidance mode, a soldier uses a fold-down chest display to view an image of the battlefield provided by the recon bird. After commanding the recon bird to change its image and locate a target, the soldier then uses a joystick to move a crosshair on the display onto the target in the viewfinder, and provides instruction to lock the range information and fire the missile. The recon bird provides its location to the missile system and provides range and target bearing information to the target to be destroyed on the battlefield. The missile is further provided with a recommended flight profile to avoid terrain obstacles such as mountain ranges, and then the missile is fired. The missile maintains its communication link with the recon bird, and begins by gaining altitude and heads in the current direction of the recon bird, so that it can assume a similar line of sight to target, once it approaches the recon

bird, it changes direction to point at a similar direction to the bearing of the recon bird's targeting cameras, and begins flight toward the target as directed by the ranging/bearing information being continually provided by the recon bird. In one embodiment, the soldier firing the missile maintains communication with the recon bird, and if necessary, can dynamically steer the missile by moving the joystick and crosshair on the soldier's tactical display. When the targeting information is updated by a soldier in such a manner, the recon bird communicates the new coordinates to the missile so that it can be steered appropriately. Then once the tactical missile begins the terminal phase of its flight profile, it uses a camera in its nose to obtain imaging data, digitize the data, and extract a terrain shape grammar that provides the missile with a model of the terrain and the location of the target within that terrain. Using its guidance system as well as the data furnished by the recon bird, the missile adjusts its trajectory to guide itself into the target, providing for course corrections as its own terrain recognition system extracts terrain and target features, and updates the missiles flight profile information. In this manner, the tactical missile can be guided to target through automatic or semi-autonomous optical tracking means, and the recon bird's literal "bird's-eye view" can provide immediate damage assessment to the soldier who is viewing the video image.

[0088] Defenses such as tactical combat laser systems are being developed against such threats as tactical missiles. The tactical missile of the present invention provides a number of countermeasures against tactical laser systems. First, spatial and temporal diversity of the darts and main missile's explosive payload complicate the very difficult task of acquiring, tracking, and targeting the missile with the tactical laser, as the multiple targets moving at multiple mach velocities would be almost impossible to completely destroy. Further, one embodiment of the present invention provides for countermeasures against the laser energy by providing for a

ceramic skin over the tactical missile's outer shell, ablative armor over the missile skin that vaporizes into a fog-like vapor to inhibit deep laser penetration, and/or a highly laser-reflective skin such as polished titanium that reflects laser energy.

[0089] In yet another embodiment, the tactical missile of the present invention comprises a seeker head in the forward section of the missile that can track laser emissions (direct, reflected, ambient, or combination) from a battlefield laser system. By guiding the missile to the source of the laser radiation, in similar fashion to the High-Speed Anti-Radiation Missile (HARM) that attacks radar facilities from detecting emissions, this embodiment of the tactical missile is capable of destroying tactical laser systems in the same fashion. Further, in one embodiment, the tactical missile comprises a dual laser sensor and infrared seeker head that not only searches for sources of laser energy, but also the waste heat generated by the power facilities that energize such lasers. In this manner, even if a laser facility turns off its beam, the infrared seeker will still provide sufficient guidance to destroy the laser generation facility. In yet another embodiment, if either the laser energy source and/or the infrared source are no longer visible, the tactical missile may change guidance modes to ballistic, so that the missile may simply attack its last known target by straight-line approach.

Shoulder-Fired Automatic Large Caliber Rifle

[0090] Among the problems mentioned above for the infantry soldier is the need to have an automatic, high-power weapon that is capable of penetrating walls in an urban environment, yet designed to be carried by infantry and fired with little notice from the shoulder without the need for tripod mount. These weapons are particularly valuable in firing through walls, doors, and floors when a known enemy is taking cover behind structural features of buildings. Such weapons require an innovative design so that the rifle may chamber large

rounds (such as the standard .50 BMG round currently used in US forces) yet still be manageable when shoulder fired by a soldier in automatic mode.

[0091] The improved large caliber rifle of the present invention comprises an operating system based on the US Military's M-14 7.62 mm rifle, but with significant modifications and enhancements to accommodate large caliber rounds such as .338 Lapua, .300 Winchester, .300 Winchester Short Magnum, and .50 BMG while making recoil manageable in a shoulder-fired scenario. Similar to the M-14 (See FIG. R1), the rifle of the present invention is gas operated, magazine fed, and is of a selective fire or fully automatic design (overall embodiments of the rifle of the present invention are illustrated in Figures S1, C1, D1, and E1). The gas system (S1a) is located under the barrel (S1b), and has a gas piston (FIG. S5, S1c) which operates the operating rod assembly (FIG S5, S1d). Similar to the M-14, one embodiment of the rifle features a gas system with an automatic gas pressure relief port (FIG. S6, S1e), which may limit the amount of gases used to operate the weapon. The rotating bolt (FIG. S8, S1f) is similar in design to the prior art M-14 design (FIG. R1, 32z). Improved features of the present invention further comprise a moving barrel and receiver system (FIG. C9, C9a, FIG. C15, C9a) a new barrel and bolt latch timing system (FIG. L5, L5a; FIG. L21, L5a), improved barrel location and support features (FIG. B1, B1a; FIG. B12, B1b) embodiments of barrel recoil mitigation springs and shocks (FIGs. C5, C6, C10, C13, C15, C18 S27f; FIGs. D1, D2, D7 D1a; FIGs. E1, E2, E3, E4 E6, E4, E6, E8, E1a; FIGs G1-G16), a means of assisting with barrel recoil (FIGs. F2-F18), a revised feed ramp design (FIGs. S16-S27) and barrel location and support system (FIG. B12, B1b; FIGs. H1-H11), a muzzle brake (S1g) to further mitigate recoil and muzzle rise (such as the muzzle brake shown and described in U.S. Patent No. 6,425,310, the

disclosure of which is fully incorporated by reference herein for all purposes), and a buttstock incorporating spring or shock absorber assemblies.

[0092] The barrel of the present invention departs from the previous M-14 style design in a number of ways. First, the barrel is physically dimensioned and chambered to accept rounds other than the 7.62 mm NATO round, for instance the .50 BMG round used by the U.S. Military, the high-power high-accuracy .338 Lapua round, or the .300 Winchester short magnum round.

[0093] FIG S20 illustrates a cartridge (S22b) extending from the top of a magazine (S27d) and a bolt (S1f) engaging the cartridge at its rim base (S20a) and preparing to feed the cartridge into the chamber (S27a). Referring to FIGs. S22 and S27, one embodiment of the of the present invention comprises a barrel (S1b) having a proximal end (near the breech end) of rifle (S13b) and a distal end (or near the muzzle) of rifle (S13b) (see FIG S1), with an interior cylindrical space forming a chamber (S27a), the opening of which further comprises a chamfer (S27b) in proximity to the feed ramp (S27c). An alternate cutaway illustration is also shown in FIG. S30. Returning to FIG. S22, the angle of the chamfer (S27b) with respect to the central axis of barrel (S1b) is designed to produce a substantially smooth transition for the tip (S22a) of a bullet being fed from a magazine (27d) up a feed ramp (S27c) and into the breech end of the bore of the barrel (S1b); additionally, the angle of chamfer (S27b) allows the cartridge (S22b) to progress down the feed ramp (S27c) and be loaded into the chamber (S27a) as the bolt (S1f) pushes the cartridge forward toward the barrel's distal end and into battery position in the chamber (S27a) from its storage position in the magazine (S27d). FIG. S23 illustrates cartridge (S22b) partially disposed in chamber (S27a) as the cartridge is being fed distally into battery position in the chamber (27a). In FIG S24, cartridge (S22b) is now substantially aligned with

the central axis of the barrel (S1b) and continues to be fed distally by bolt (S1f). FIG. S25 illustrates Cartridge (S22b) fully seated in the chamber and ready for battery while bolt (S1f) locks to provide support for the detonation of the cartridge (S22b) upon firing. Note also that the chamfer (S27b) terminates at the forward (distal) end of the extractor groove (S25a) so that the head of the cartridge case is supported while pressure builds up within the cartridge case after firing.

[0094] Turning to FIG. S27, another illustration of the breech end of one embodiment of the barrel (S1b) of the present invention is shown with the magazine (S27d), and a cartridge (S22b) ready for feeding into chamber (S27a). The remainder of the receiver and stock have been removed from the drawing for illustrative purposes. Attached to the barrel (S1b) are recoil guide rods (S27e) with recoil mitigation springs (S27f). The rods (S27e) may be attached to the barrel (S1b) through any number of conventional means, including welding, lug and grove, fastener attachments, or alternatively, may be integrally manufactured with the barrel (S1b) in a single assembly. The rods (S27e) may extend back through cavities in the buttstock of the rifle (S13b) (See FIG. S31), and through a spring termination in the end of the buttstock, allow the barrel to recoil and the impulse to be absorbed in the compression of the spring (S27f).

[0095] Figures S13, S14, and S15 illustrate the ability of the barrel (S1b) to recoil after firing. In FIG S13, barrel (S1b) is shown in its most forward position, in battery, and ready to fire. The distance between the piston support to forestock (S13a) is at its maximum while the rifle (S13b) is ready for firing. Turning to FIG S14, the rifle (S113b) has been fired, and distance (S14a,), reduced to illustrate the barrel recoiling toward the breech end of the rifle (S13b). In FIG S15, one embodiment of the barrel (S1b) is shown fully recoiled, with the

distance S15a at a minimum compared to distances (S14a) and (S15a). After fully recoiled, force provided by recoil springs (S27f) and operating rod spring (S12a) work together to relocate the barrel (S1b) distally so that it moves back into battery position as shown in FIG. S13.

[0096] Similar to the operating system of the M14, FIGs S2-S12 illustrate the gas portion of the operating system of one embodiment of the present invention. In FIG. S2, cartridge (S22b) is chambered in a ready-to-fire position within barrel (S1b). Turning to FIG. S3, the rifle (S13b) is fired, causing bullet (S3a) to move distally down barrel (S1b). In FIG. S4, bullet (S3a) has just passed gas port (S5a), which provides a path for the expanding gas from the gunpowder combustion to vent to the gas piston cavity (S1c1) formed between gas piston (S1c) slidably disposed within the gas cylinder (S1c2). FIG. S5 illustrates in close up the bullet (S3a) passing gas port (S5a) which will allow combustion gas to vent into cavity S1c1. FIG. S6 illustrates the gas piston (S1c) being driven rearward (proximally) by gasses escaping from the barrel (S1b) into the cavity (S1c1) and further moving rearward (proximally) the operating rod assembly (S1d). Also shown is one aspect of the invention whereby a port in the gas piston cavity (S1c1) of the gas piston (S1c) aligns with a port in the gas cylinder (S1c2) of the gas assembly (S1e) to provide a gas pressure relief port, allowing tuning of the amount of force delivered by the gas piston (S1c) to the operating rod assembly (S1d).

[0097] Turning to FIG. S8, the operating rod assembly (S1d) is shown in its rearmost position after being driven back by the gas piston (S1c). At this point, the bolt (S1f) is fully retracted, allowing for extraction of the spent cartridge casing and the beginning of the feed cycle to chamber another cartridge. The operating rod spring (S12a) and recoil guide springs

(S27e) provide forward force to move the operating rod assembly, and thereby the bolt, back into its forward and locked position.

[0098] As described herein, the barrel of the present invention is allowed to recoil and move back into battery position with each firing. A mechanism is further provided in one embodiment to guide the barrel longitudinally along its central axis as it moves through the recoil-reload cycle while still minimizing angular rotation about its central axis and thus ensuring accuracy. Referring to FIG. B1, a bottom view of the receiver (B12a) is shown with barrel (S1b) extending into the receiver cavity. A barrel guide slot (B1c) is formed as a cavity longitudinally along the bottom of the barrel (S1b), within which a barrel guide (B1b) that is attached to the receiver (B12a) engages slidably to maintain barrel rotational and orthogonal alignment as the barrel recoils during the recoil-reload cycle. The barrel guide (B1b) is further shown in FIG. B12 attached and extending from the receiver (B12a). As further shown in FIG. B2, although a variety of shapes could be used for barrel guide (B1b), the shape of the corresponding barrel guide slot (B1c) is chosen to closely match the shape of the barrel guide (B1b) so that the chamber (S27a) is provided additional mechanical support by the barrel guide (B1b) when a cartridge (S22b) is fired within the chamber (S27a) of the barrel (S1b). Further, FIG. B14 illustrates a close-up view of the breech end of the barrel (S1b). Disposed along the bottom of the chamber opening (S27a) is shown the barrel chamfer (S27b) and underneath, the proximal end of the barrel guide slot (B1c) that slidably engages with the barrel guide (B1b, not shown). One embodiment of the barrel recoil rods (S27e) are shown attached to the barrel (S1b).

[0099] The barrel of the present invention provides for a reduction in felt recoil but also requires a timing relationship to be maintained between the action of the operating rod

assembly (S1d), the bolt (S1f), and the recoil of the barrel (S1b) with respect to the receiver (B12a). If timing between movement of these elements is not maintained, it may be possible that a cartridge (S22b) will not be properly fed by the bolt (S1f) if, for instance, the barrel has not yet had time to return to battery position before the cartridge feed process occurs. Therefore, one embodiment of the present invention provides for a progressive locking mechanism (L5a) that locks the bolt with respect to the barrel and maintains proper feed mechanism timing.

[00100] In one embodiment, the operation of the rifle (S13b) and latching mechanism (L5a) is described as follows, also shown in the previously referenced drawings and in FIGs. L1-L22 and B14-B24. First, the trigger of the rifle (S13b) is pulled, causing a firing pin to strike the primer of the cartridge (S22b) and igniting gunpowder to fire a bullet (S3a) down the barrel (S1b). As previously explained, the bullet (S3a) passes the gas port (S5a), causing the gas piston (S1c) to expand, and providing force to move the operating rod assembly (S1d) rearward. As a result, the bolt (S1f) moves backward, allowing the spent cartridge to be ejected from the receiver. A locking mechanism shown in FIGs L3 and L4 (L5a), locks the bolt (S1f) in the open position and prevents it from moving forward again until the barrel has completed its recoil cycle. This is accomplished through two rotating latches (L3a, L3b) that progressively and rotatably engage and disengage with notches (such as FIG. B17, B17a). As the FIG. B17 shows, to reduce mechanical noise the end of a latch (L3a or L3b) opposite its hinged end is slightly radiused with respect to the axis of rotation about its hinged pivot, and the notches (B17a) are correspondingly radiused to provide a smooth sliding motion of the latch into and out of the notch (B17a). The bolt is shown locked in FIG. L4, with a first latch, (L3a), having engaged a notch, being held in the notch by a latch spring (L3a1). After the bullet

(S3a) exits the barrel (S1b), the piston chamber (S1c1) vents, and the barrel continues on its rearward recoil. A raised lobe (FIG. B23, B23a) on one of the recoil guide rods (S27e) engages with the latches (L3a, L3b) to release them from their latched positions at the correct time (see, e.g., FIG. B22, B23a, L3a). After reaching its rearmost position, the barrel begins to be pushed forward back into battery position through the pressure exerted by the recoil mitigation springs (S27f). On the barrel's forward path, the first latch (L3a) holding the bolt (S1f) is released by the lobe (B23a) on a recoil guide rod (S27e), then the second latch (L3b) first engages to continue to delay the return of the bolt while the barrel continues to return to battery, and then is eventually released by the lobe (B23a) as the barrel continues its forward motion, thereby allowing the bolt to prepare to feed a new cartridge (S22b) from the magazine (S27d). After the barrel seats in its forward battery position, the bolt (S1f) through its final forward motion feeds the next cartridge from the magazine (S27d) into the chamber (S27a) of the barrel (S1b). Both latches (L3a, L3b) are free and unlatched at this point. Finally, a rotation of the bolt (S1f) locks the bolt through lugs extending orthogonally from its central axis, and the rifle is then again ready to fire.

[00101] The implementation of the recoil energy-absorbing mechanism may vary depending on the particular round being chambered and the desired cyclical fire rate and characteristics of the rifle. To that end, additional embodiments of the recoil absorbing mechanisms are disclosed. Turning to FIGs. C19 and C20, the terminus of the recoil guide rods (S27e) are shown impinging on the recoil mitigation springs (S27f). The base of the rods (S27f) further comprises an orifice (S27e1) that allows air to pass as the rod first compresses the spring (and air trapped in the buttstock cavity that houses the spring (S27f)). The orifice (S27e1) is chosen of such a dimension that the air may be compressed to add further

progressive resistance to the rearward motion of the barrel (S1b), further providing for energy absorption. Further, if the spring design of recoil springs (S27f) is sufficient, the orifice (S27e1) is designed to allow air to flow freely without substantial resistance. Those of skill in the art also recognize that a plurality of orifices could be used to mitigate the forward and rearward resistance presented to the recoil guide rods (S27e).

[00102] Further embodiments of the recoil mitigation springs are shown in FIGs. G12-G16. As an additional improvement to a loose spring, an assembly (G12a) to house the springs and provide for an orificed entry and exit of gas is provided. Referring to FIG. G14, the assembly (G12a) is shown in cutaway format comprising a housing (G12a1) open only at one end, within which assembly is further located a primary recoil mitigation spring (G12a2), an optional secondary counter-coiled recoil mitigation spring (G12a3), and a ported compression valve (G12a4). The recoil guide rods impinge on the valve G12a4, and compress the springs and gas held within the assembly (G12a) to dissipate the barrel recoil energy. The optional second counter-coiled spring provides a stepped, non-linear response to recoil, whereby the initial energy quenching provided by the primary spring (G12a2) is at one force level, and the final distance of travel of the guide rods impinges secondarily on the second spring (G12a3). FIGs. G1-G11 further illustrate embodiments of the assembly (G12a1) and FIG. G5 illustrates how three of the assemblies (G12a) may be disposed to mitigate recoil from the recoil guide rods (S27e). The springs (S27f) or assemblies (G12a) are shown in one embodiment, located within the buttstock of the rifle as shown in Fig G3. Further, the recoil valve (G12a4) may comprise a check valve design as illustrated in FIGs. G9, G10, and G11. In this embodiment, the recoil guide rod (S27e) impinges on the base plate of the valve (G12a4), compressing the springs and the gas trapped within the housing of the spring assembly. Gas is allowed to flow

both in and out of the cylinder through orifice (G9b), which orifice geometry is determined by the desired resistance imparted by turbulent fluid flow through said orifice. A second orifice (G9a) allows fluid flow only upon decompression of the spring assembly, which allows the compression of the gasses trapped within the spring assembly housing (G12a1) to offer compressive resistance to assist in mitigating recoil, but less resistance upon return of the barrel to battery position since the check flap (G9c) is designed only to cover the selective orifice (G9a) upon spring compression by the recoil guide (S27e).

[00103] An additional embodiment of the barrel and receiver of the present invention is illustrated in FIGs. H1-H11. As the barrel moves back and forth during its recoil, a vacuum in spaces within the barrel locator or receiver may be created that impedes the motion of the barrel, and if excessive, may substantially impair the cyclical fire rate of the rifle. As FIGS H1-H11 show, there is provided an orifice (H1b) and groove (H1a) system that allows air to freely flow around barrel-supporting structures as the barrel passes through recoil phases. As the cutaway FIG. H10 illustrates, in its most forward position, the barrel (S1b) is firmly in communication with the barrel locators and receiver assembly (H10a). FIG. H9 shows the barrel recoiling slightly, and a cavity (H9a) begins to form between the barrel (S1b) and locators (H10a). As the barrel continues to recoil (FIGs H8, H7), eventually the cavity is exposed to outside air through grooves (H1a) (see Fig H7) and further, air is allowed to pass through the orifice (H1b), further reducing the vacuum impedance to barrel motion. As the barrel approaches back into battery position, however, one feature of the groove and orifice system becomes apparent; a last remainder of trapped air is captured after the grooves (H1a) have passed the seal point, and the trapped air must vent from the orifice (H1b) in a manner

preventing the barrel from "slamming" into its battery position, i.e., it uses a cushion of air to settle into its final ready-for-fire position.

[00104] Other embodiments of the present invention comprise alternate means of providing recoil mitigation springs without placing them in the buttstock. In FIGs. D1-D9 illustrate an embodiment whereby recoil mitigation springs (D1a) are disposed horizontally along the barrel (S1b). The springs are located on a guide rod assembly (D1c) that is attached to the receiver (B12a), and the springs extend into two spring compression housings (D1b) that are attached together to the barrel (S1b) through a yoke assembly (D1e). When the rifle is fired, the barrel recoils toward the buttstock (rear, or proximal) end of the rifle, and compresses the springs as the yoke assembly (D1e) is pulled by the barrel toward the receiver (B12a). The springs provide the means to absorb recoil energy, and after compression provide force to assist in moving the barrel back into battery position.

[00105] As yet another embodiment of a recoil spring assembly, FIGs E1-E18 provide for a an assembly (E1a) with a single recoil mitigation spring (E1b). In this embodiment, the single spring (E1b) surrounds the barrel (S1b) and is disposed laterally along the barrel. The distal end of the spring is seated within a recoil spring cup (E1c) that is attached to the barrel (S1d). The proximal end of the spring (E1b) is seated on the receiver (B12a). When the rifle is fired, and the barrel (S1b) recoils toward the proximal end, the spring (E1b) is compressed between the cup (E1c) that is attached to the barrel (S1b) and the receiver (B12a), and offers resistance and energy absorption to reduce felt recoil. One of skill in the art may recognize that different spring lengths and dimensions may be utilized to provide the desired recoil mitigation.

[00106] In various embodiments of the barrel (S1b), it may be desirous to provide additional force to assist with recoil of the barrel, thereby improving cyclic firing rate of the

rifle. FIGs. F1-F18 illustrate one embodiment of the present invention whereby a gas pressure cylinder is formed on the outside of the barrel (S1b), and gas from the exploding cartridge fills this cylinder and provides additional forces against the barrel to increase rearward (proximal) barrel recoil speed. Provided in this embodiment are a gas cylinder housing (F5a) that provides confinement from the expanding gunpowder combustion gasses; A forward cylinder cup (F5b) that seals substantially with the barrel (S1b) and prevents gasses from escaping in a forward direction from the cylinder housing (F5a); vent ports (F5c) in the barrel (S1b) that allow escaping combustion gasses to enter a gas cavity (F5e) formed as a space between the cylinder housing (F5a) and the barrel (S1b), and a gas vent orifice (F5f) to allow gasses to exit the cavity (F5e) after the barrel (S1b) has sufficiently recoiled. FIGs. F5-F12 show the effect of a bullet (S3a) being fired down the barrel (S1b). In FIG. F6, the barrel (S1b) is shown in its substantially forward position while bullet (S3a) makes its way down the barrel. In FIG F7, once the bullet (S3a) passes the vent ports (F5c, F7a), combustion gas is vented into the cavity (F5e) and becomes trapped between the barrel (S1b) and the housing (F5a). As the pressure builds, the trapped gas exerts force on the barrel, including the back wall of the barrel, and the barrel is accelerated backward in its recoiling state. FIGs. F8, F9, and F10 show barrel S1b recoiling backwards as gasses continue to enter the cavity (F5e) while the bullet (S3a) remains in the barrel (S1b). When a step ledge (F11a) that defines the proximal end of the barrel's closure to the cavity (F5e) reaches the vent orifice (F5f), the combustion pressure vents through an annular grove (F5h) that is cut into the cylinder housing (F5a) and registers with the vent orifice (F5f). As soon as the step ledge (F11a) of the barrel moves rearward past this annulus, gas is then vented from the gas cavity (F5e), thereby relieving the rearward acceleration forces upon the barrel. After the barrel reaches its maximum recoil distance, its barrel recoil springs

return it to its forward position, and after its gas cavity (F5e) becomes sealed by the step ledge of the barrel (F11a), trapped gas is pushed back into the barrel and out though the open muzzle as the barrel (S1b) returns to battery position. In yet another embodiment of the barrel (S1b), FIGs F13-F18 illustrate annular groves (F5g) that are cut into the barrel (S1b) so that when the barrel recoils past the vent orifice (F5f), the passage of the plurality of annular grooves (F5g) provide a mechanical wiping action to assist in removing fouling from the vent port (F5f).

[00107] While preferred embodiments of this invention have been shown and described, modifications thereof can be made by one skilled in the art without departing from the spirit or teaching of this invention. The embodiments described herein are exemplary only and are not limiting. Many variations and modifications of the system and apparatus are possible and are within the scope of the invention. One of ordinary skill in the art will recognize that the processes just described may easily have steps added, taken away, or modified without departing from the principles of the present invention. Accordingly, the scope of protection is not limited to the embodiments described herein, but is only limited by the claims that follow, the scope of which shall include all equivalents of the subject matter of the claims.

CLAIMS

What is claimed is:

1. A combat weapons system comprising:

a large-caliber rifle employing recoil mitigation techniques;

reconnaissance drone means;

means for transporting, launching, and guiding a tactical missile;

means for attacking and defeating defenses of armored vehicles;

means for conveying supplies and ammunition by infantry;

means for conveying troops through jet-assisted rotary-wing aircraft; and,

and means for automatic fire for high-yield grenades.

2. A method for infantry warfare comprising:

coordinating close-range engagement and urban assault;

projecting force and providing for battlefield infantry defense against air and armor assets; and

integrating battle tactics to maximize infantry assets.

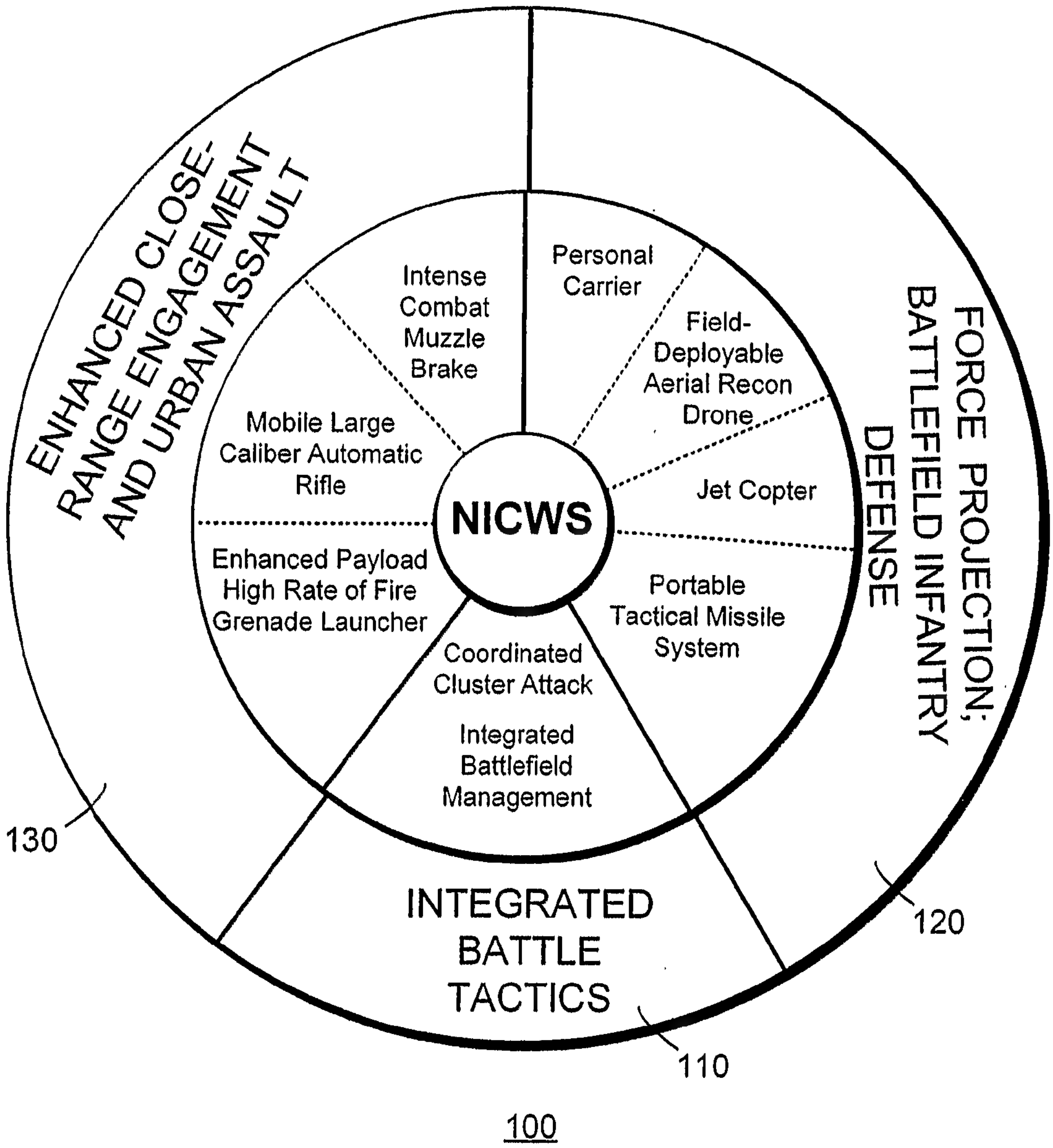

ENHANCED CLOSE-RANGE ENGAGEMENT AND URBAN ASSAULT
FORCE PROJECTION; BATTLEFIELD INFANTRY DEFENSE
INTEGRATED BATTLE TACTICS
NICWS
Intense Combat Muzzle Brake
Personal Carrier
Field-Deployable Aerial Recon Drone
Jet Copter
Portable Tactical Missile System
Coordinated Cluster Attack
Integrated Battlefield Management
Enhanced Payload High Rate of Fire Grenade Launcher
Mobile Large Caliber Automatic Rifle
130
120
110
100

FIG. 1

FIG. 2

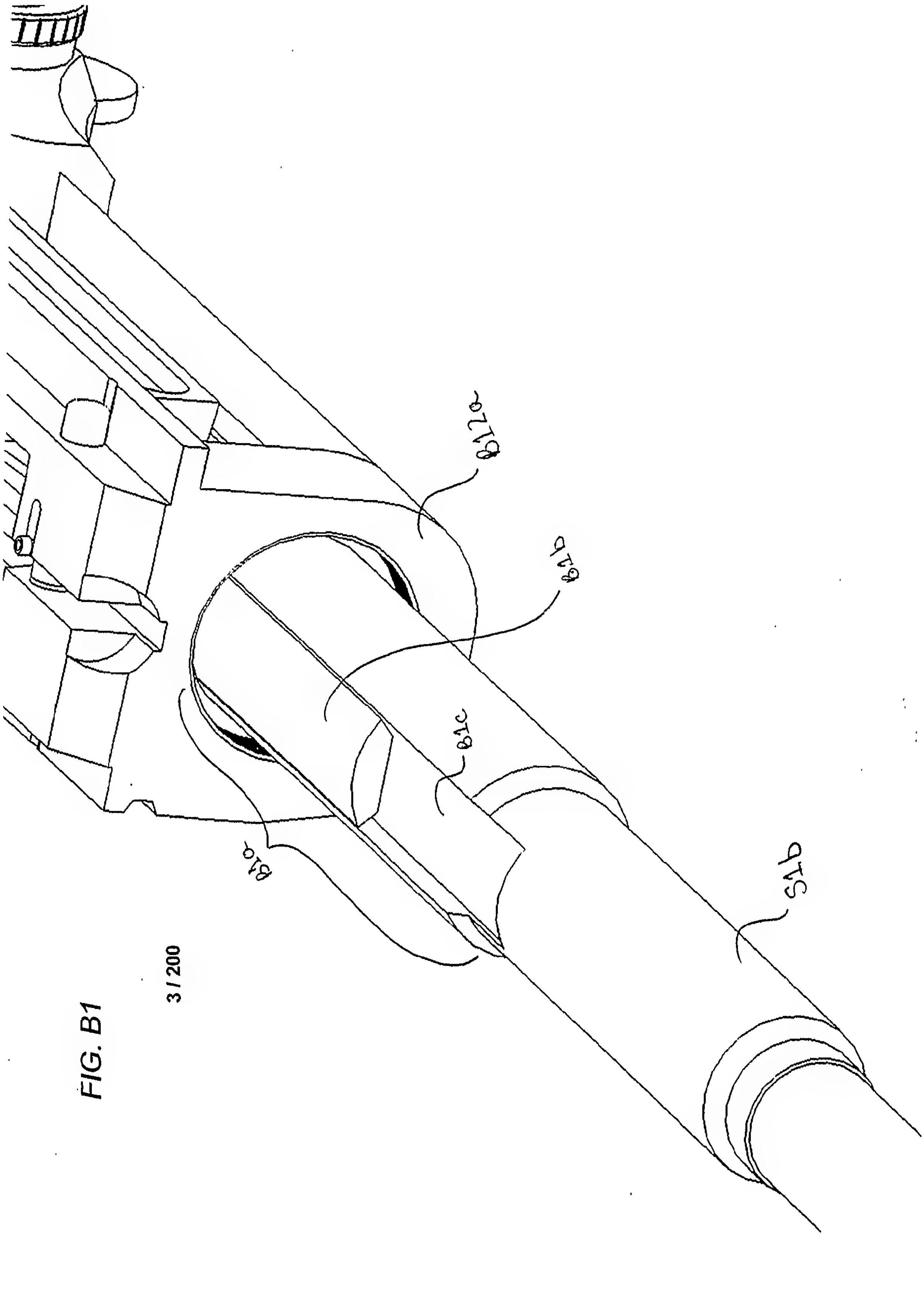


FIG. B1

3/200

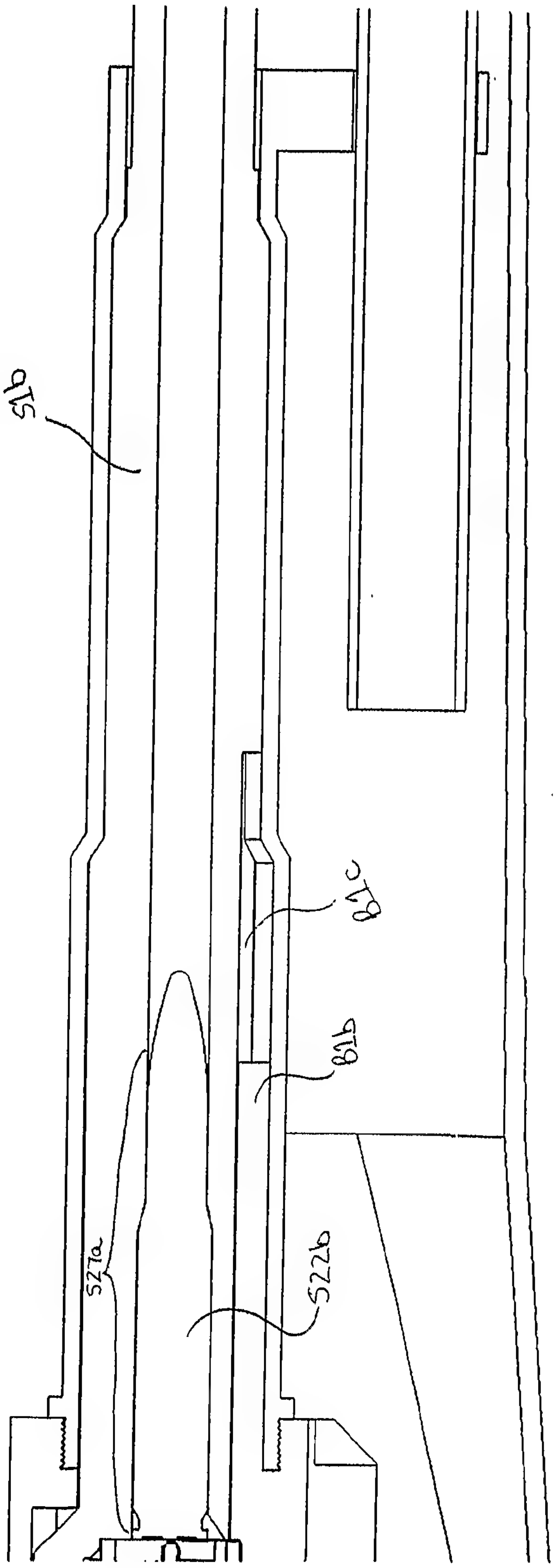


FIG. B2

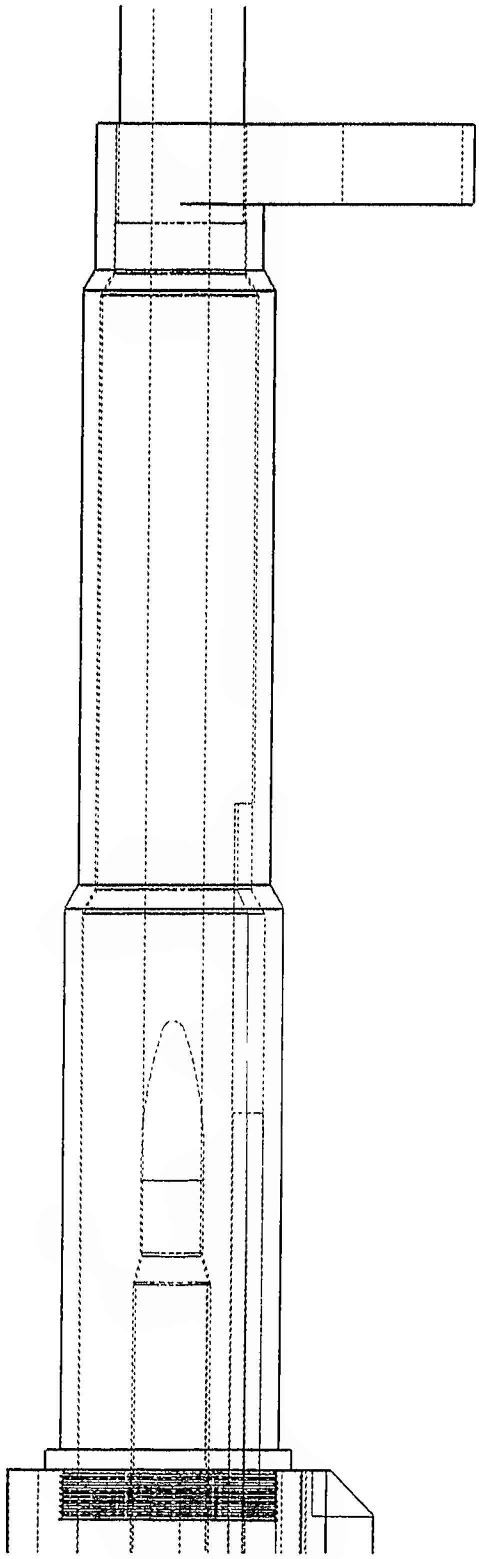
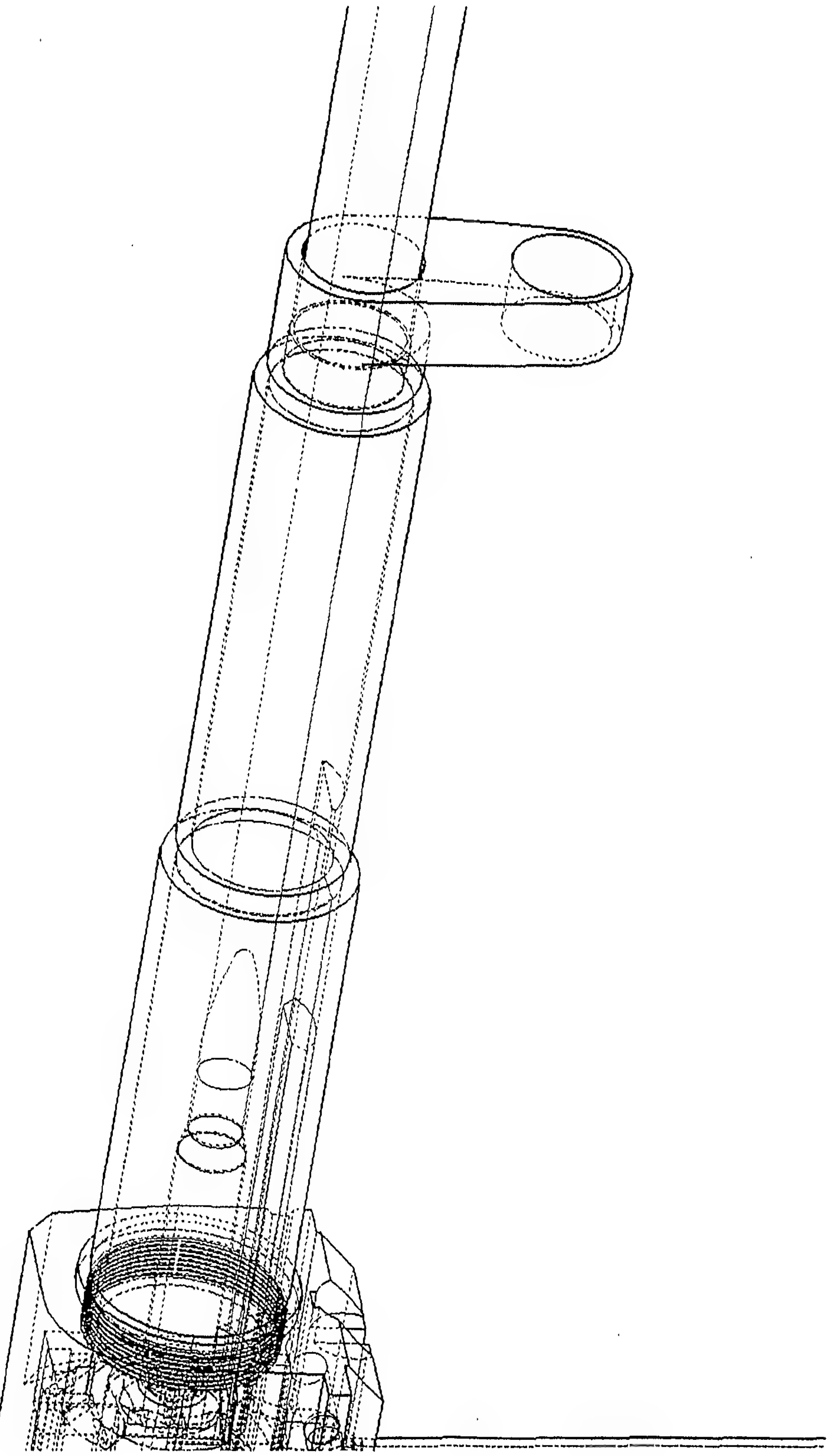


FIG. B3

FIG. B4



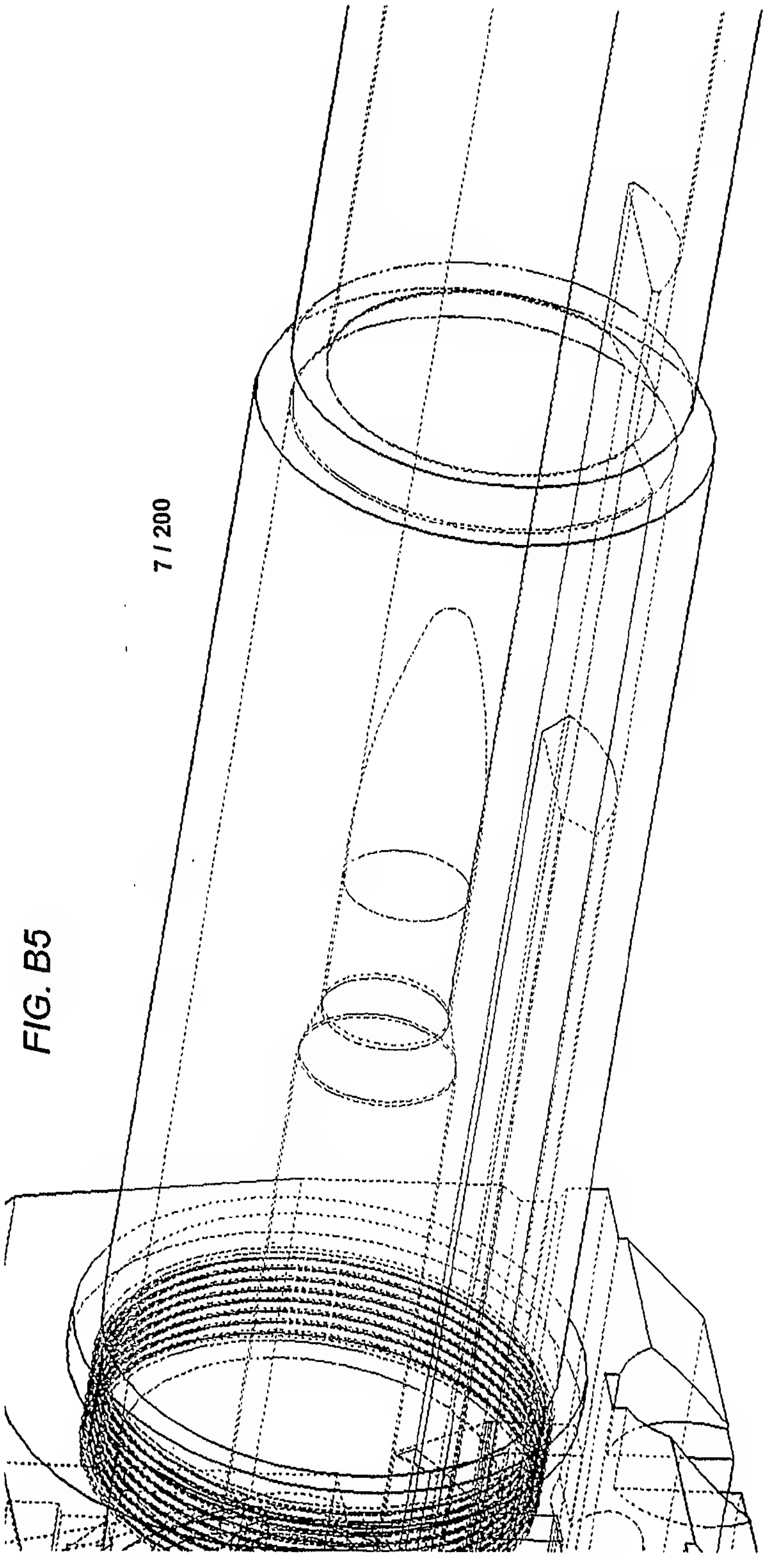


FIG. B5

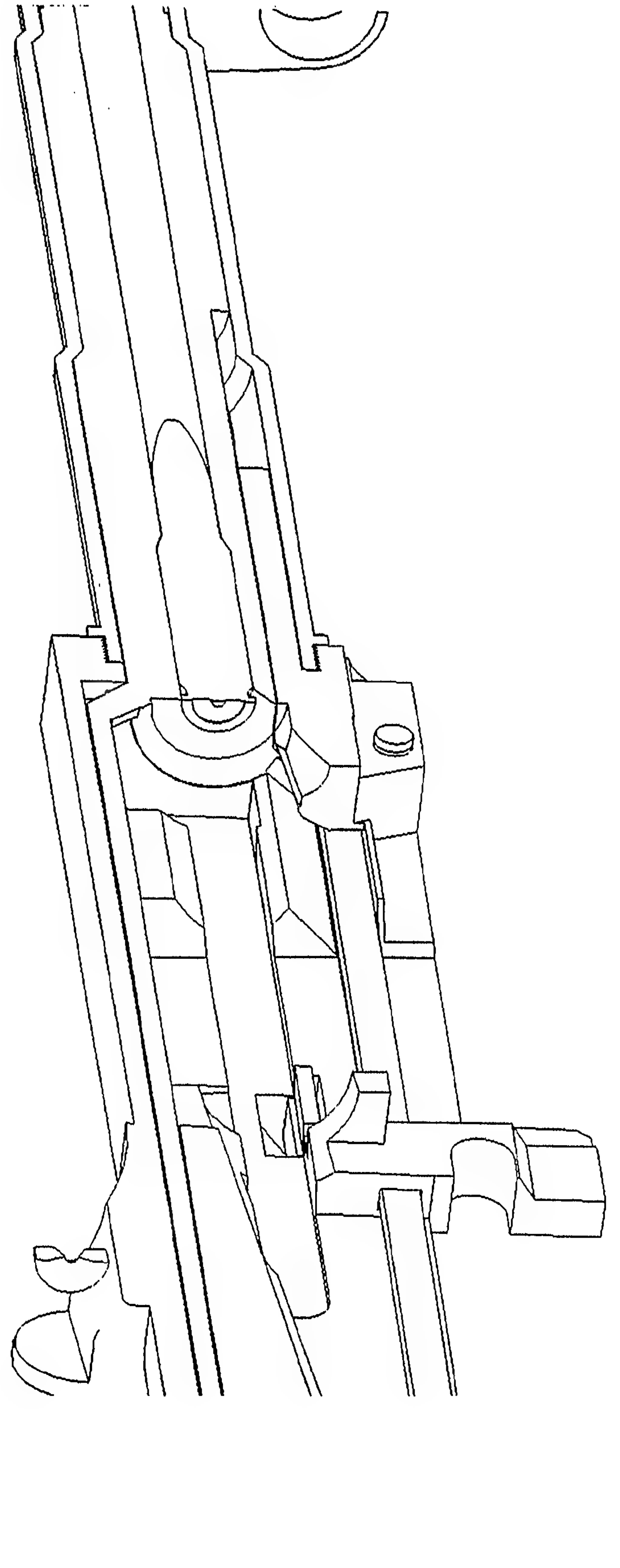


FIG. B7

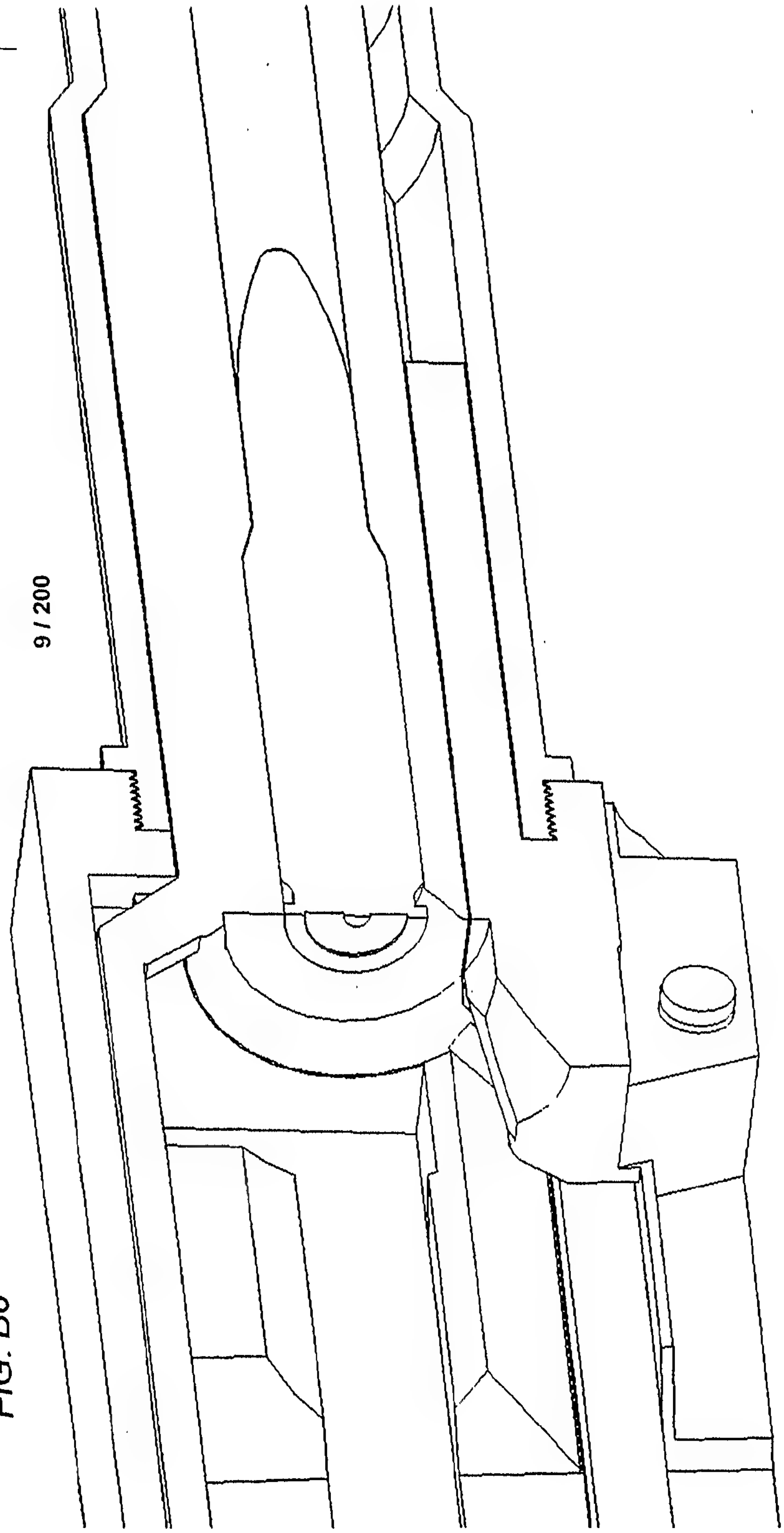


FIG. B8

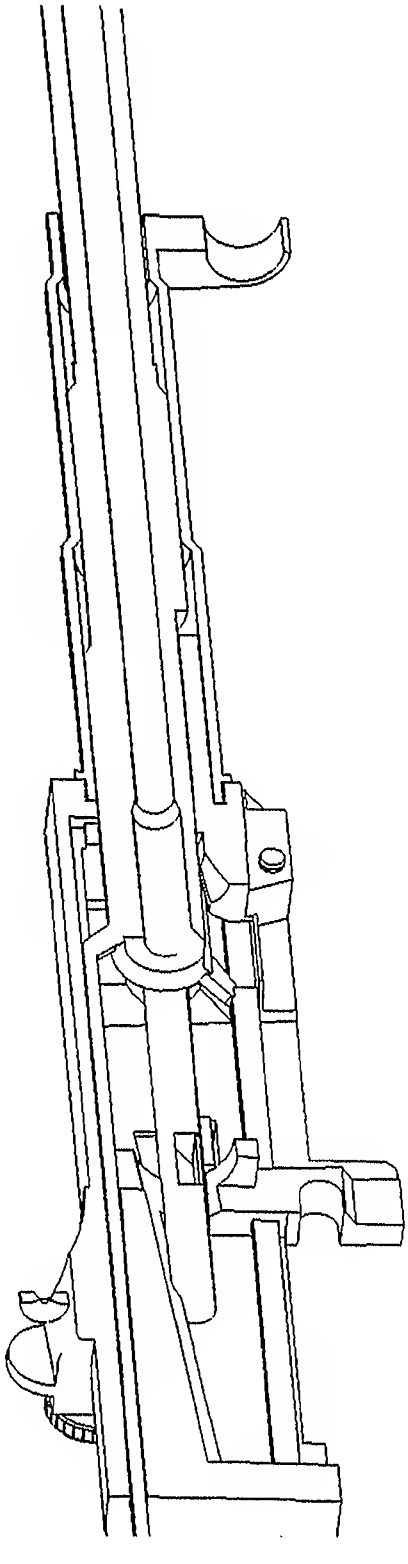


FIG. B9

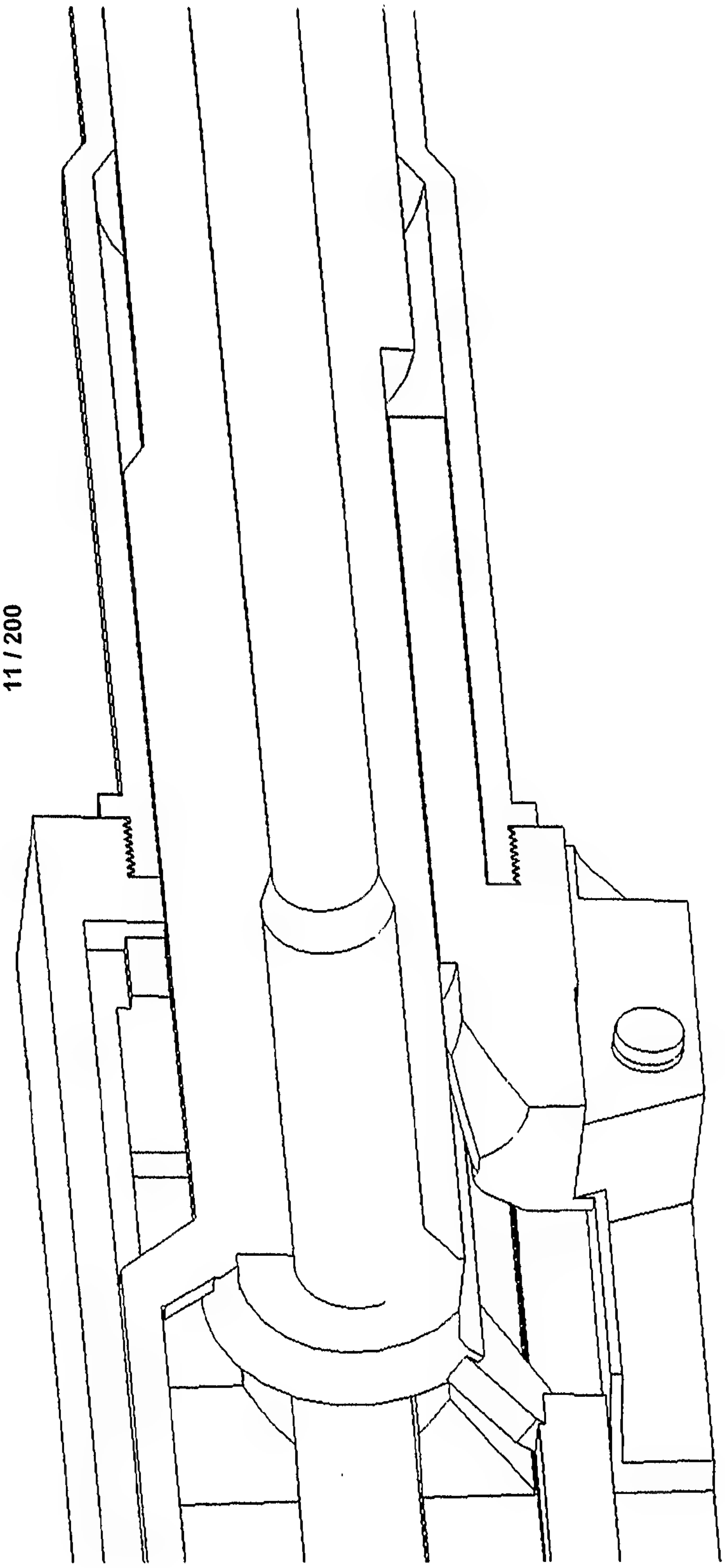
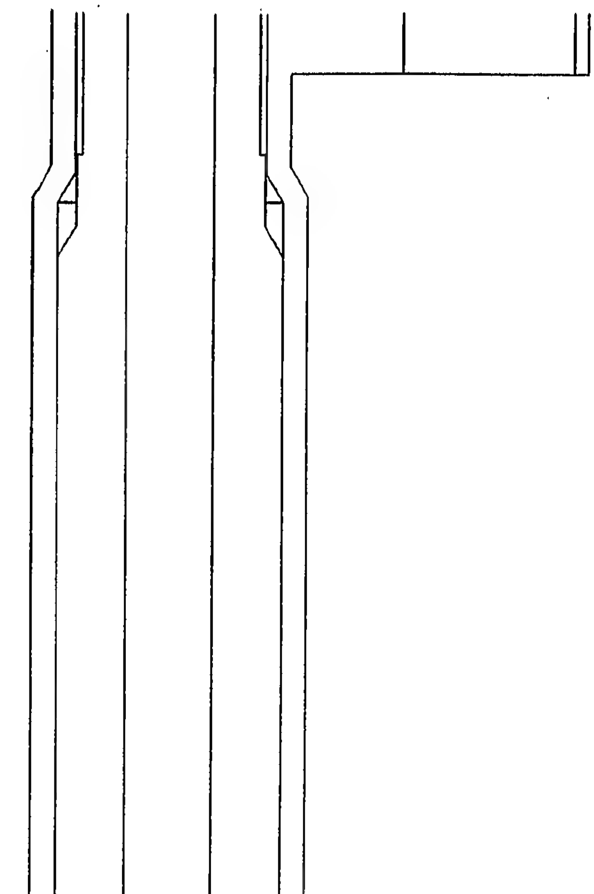


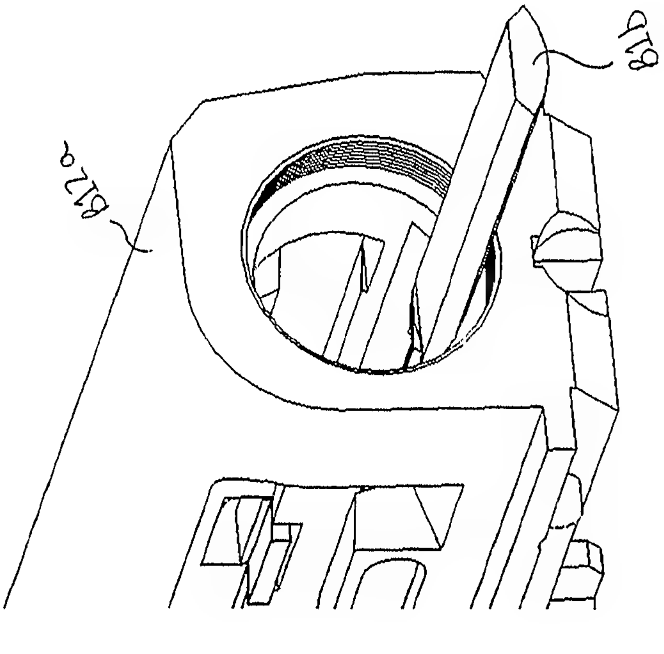
FIG. B10



12 / 200

FIG. B11

FIG. B12



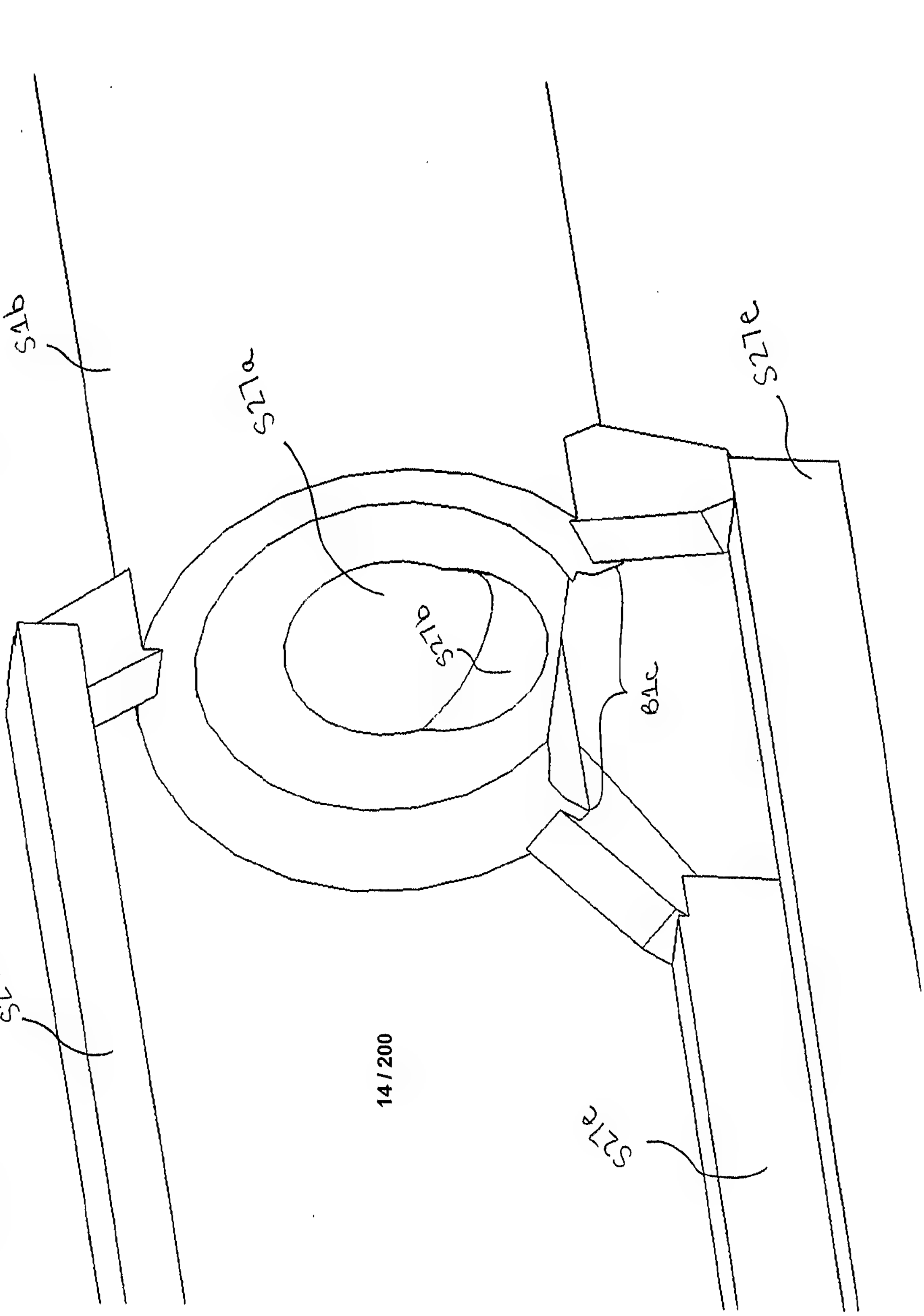


FIG. B14

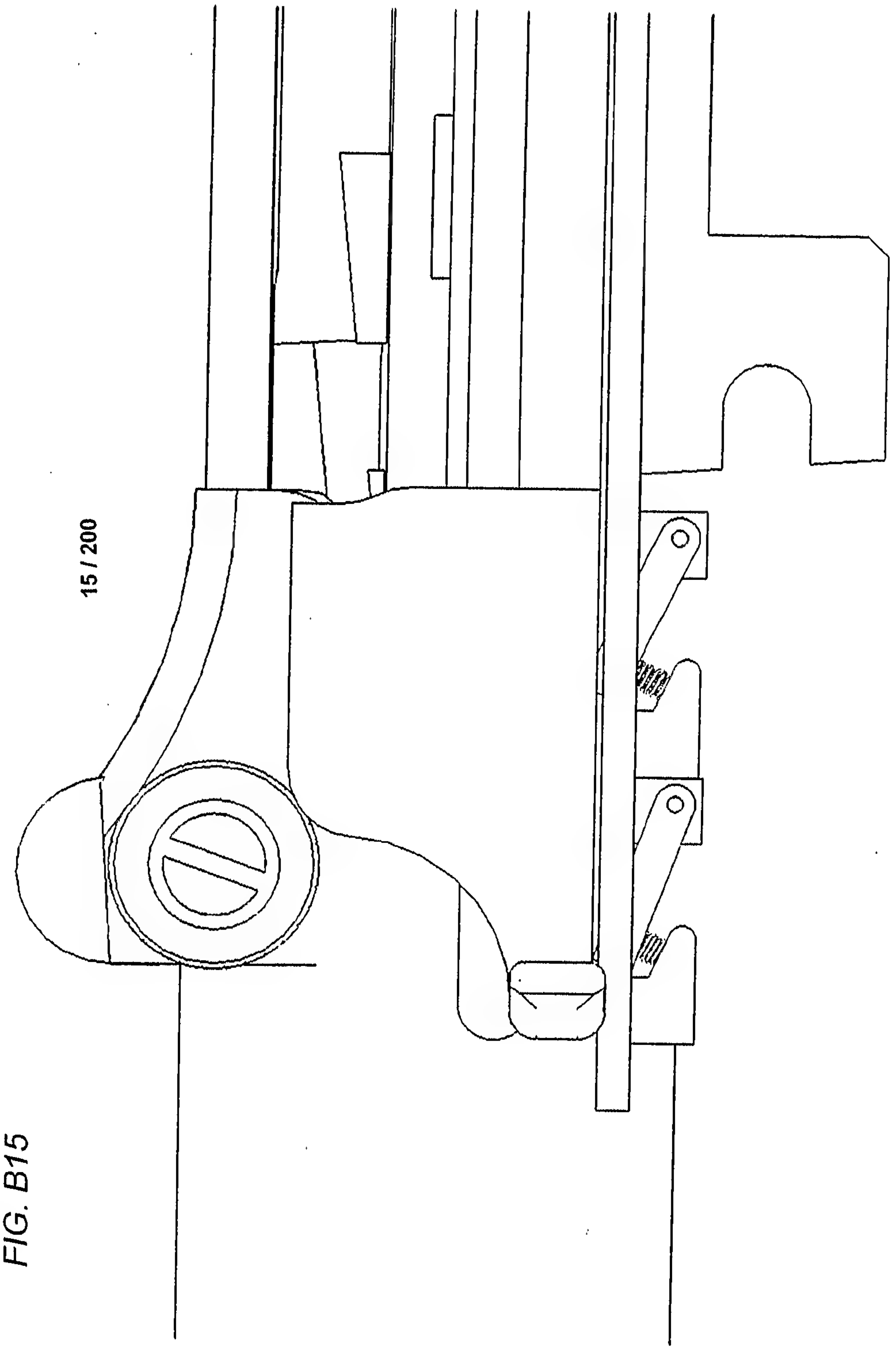


FIG. B15

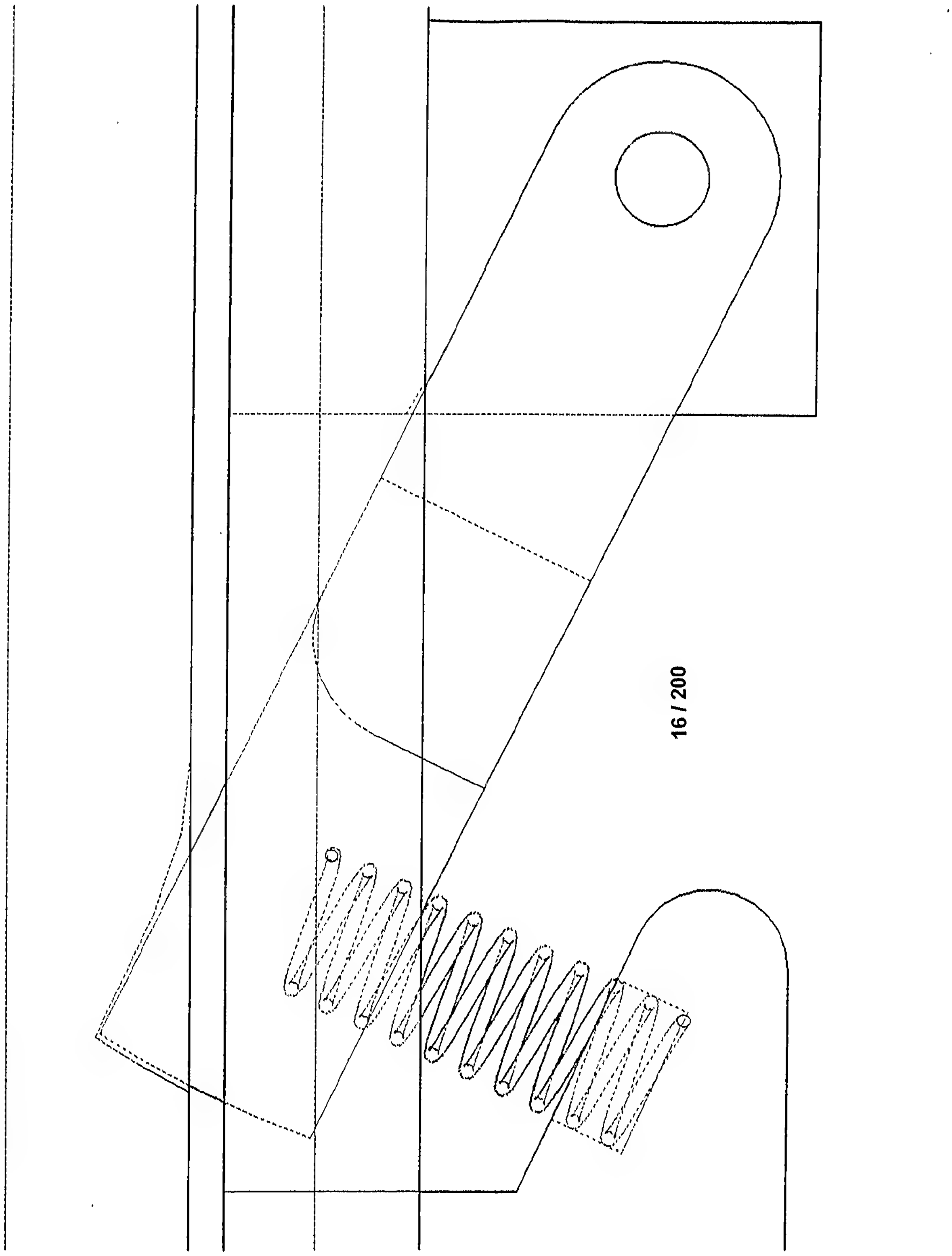


FIG. B16

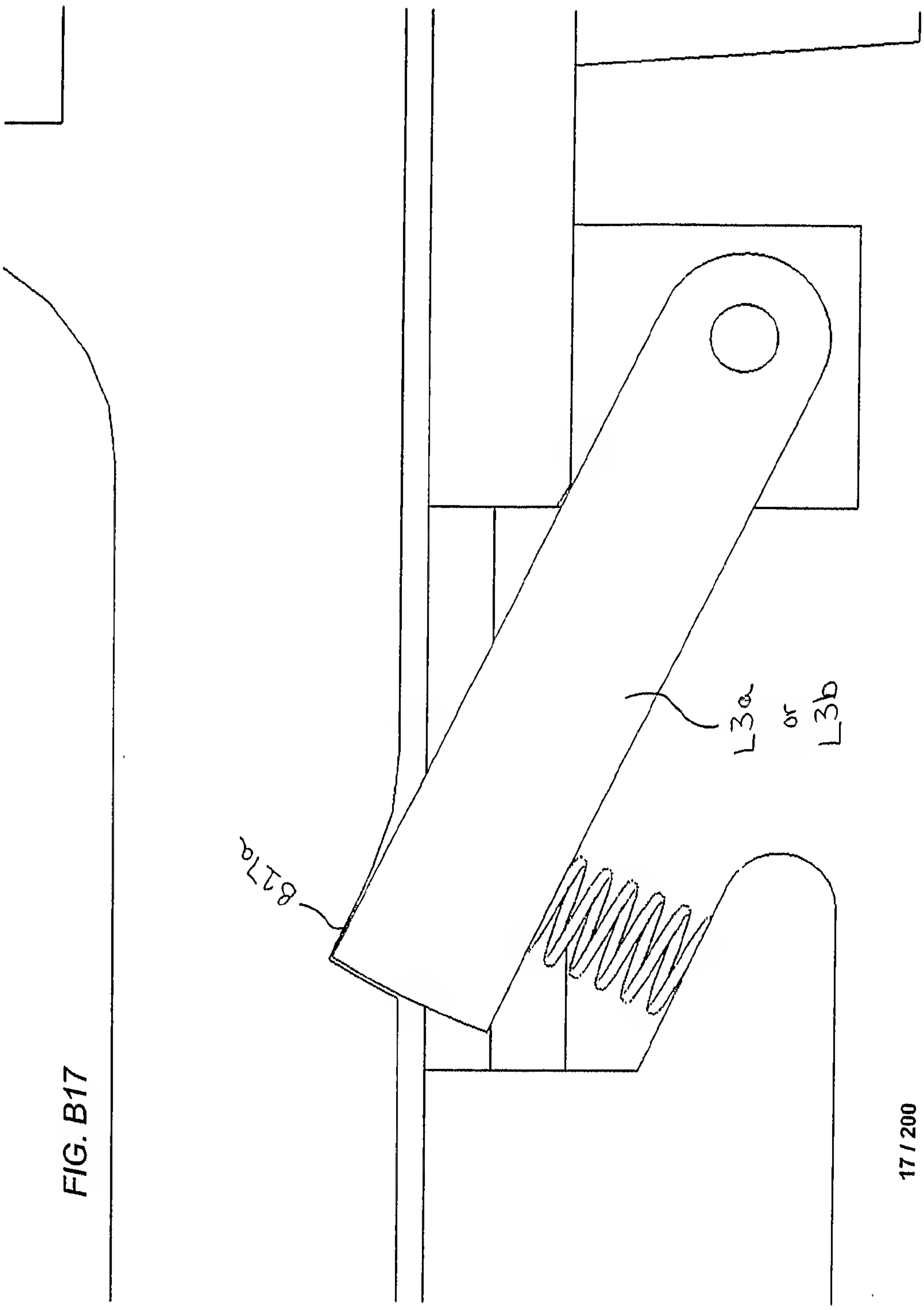


FIG. B17

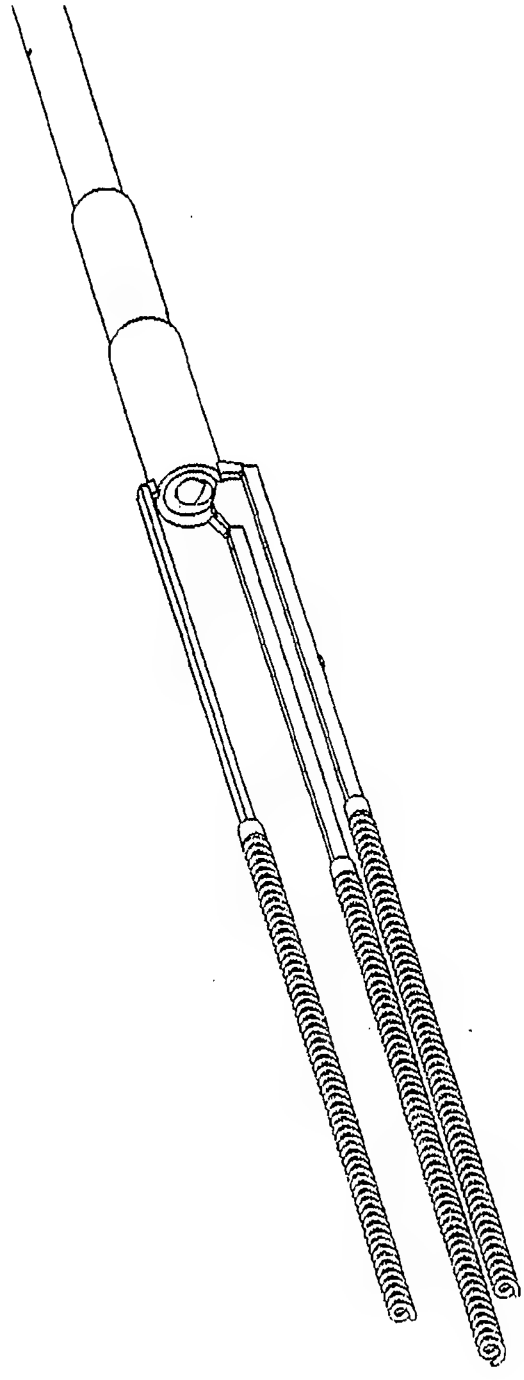
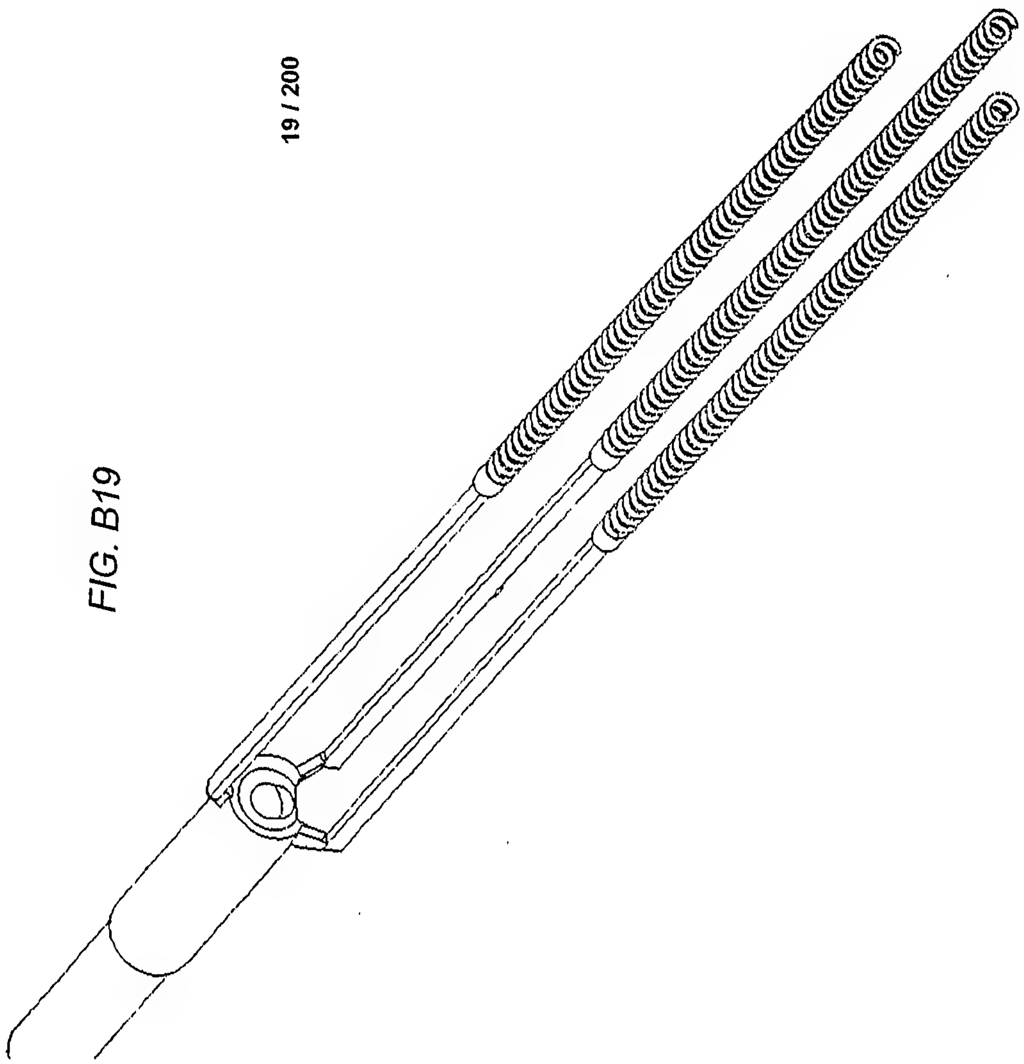


FIG. B18

FIG. B19



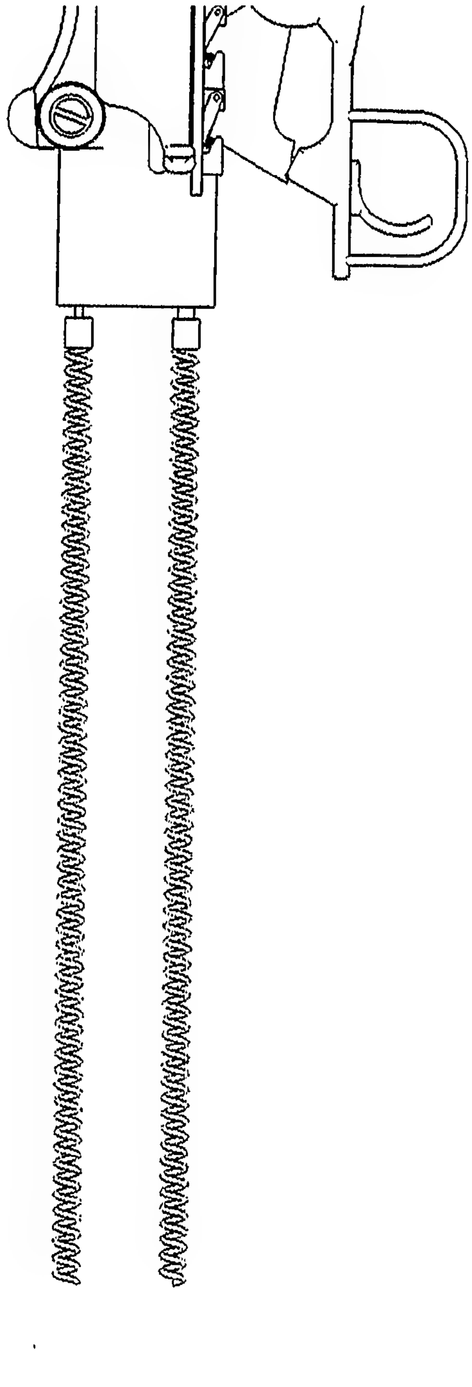


FIG. B20

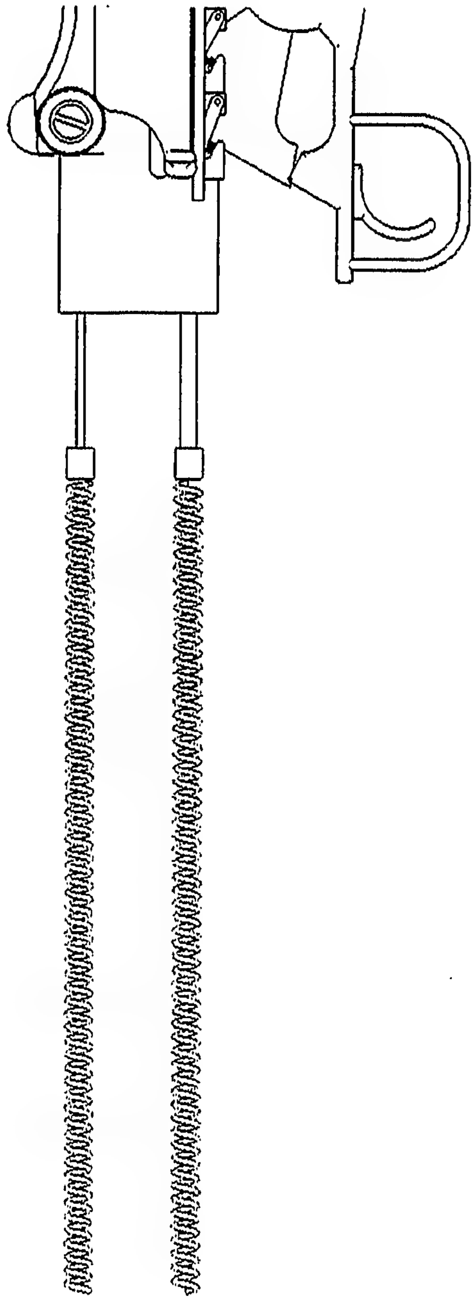


FIG. B21

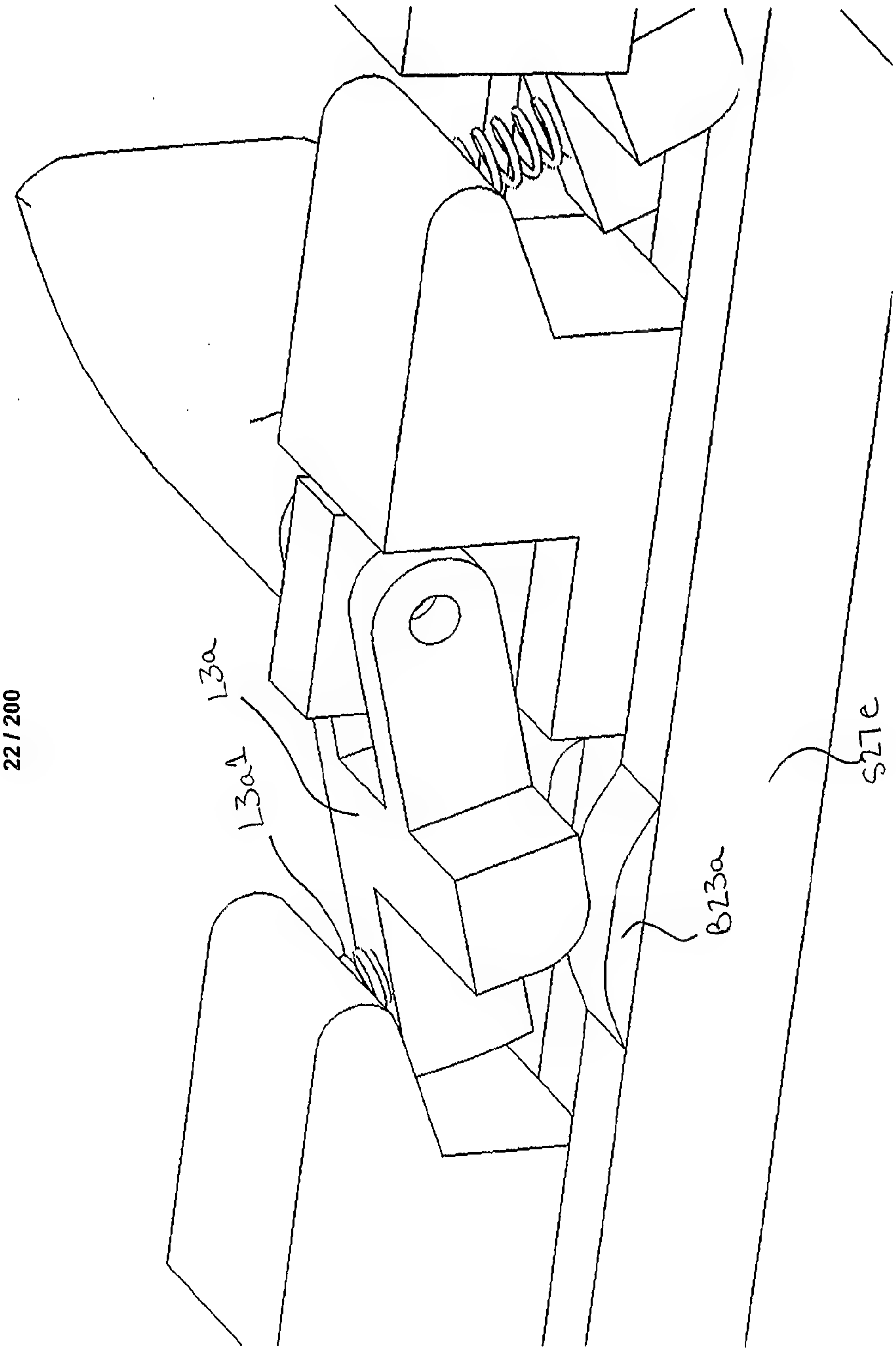


FIG. B22

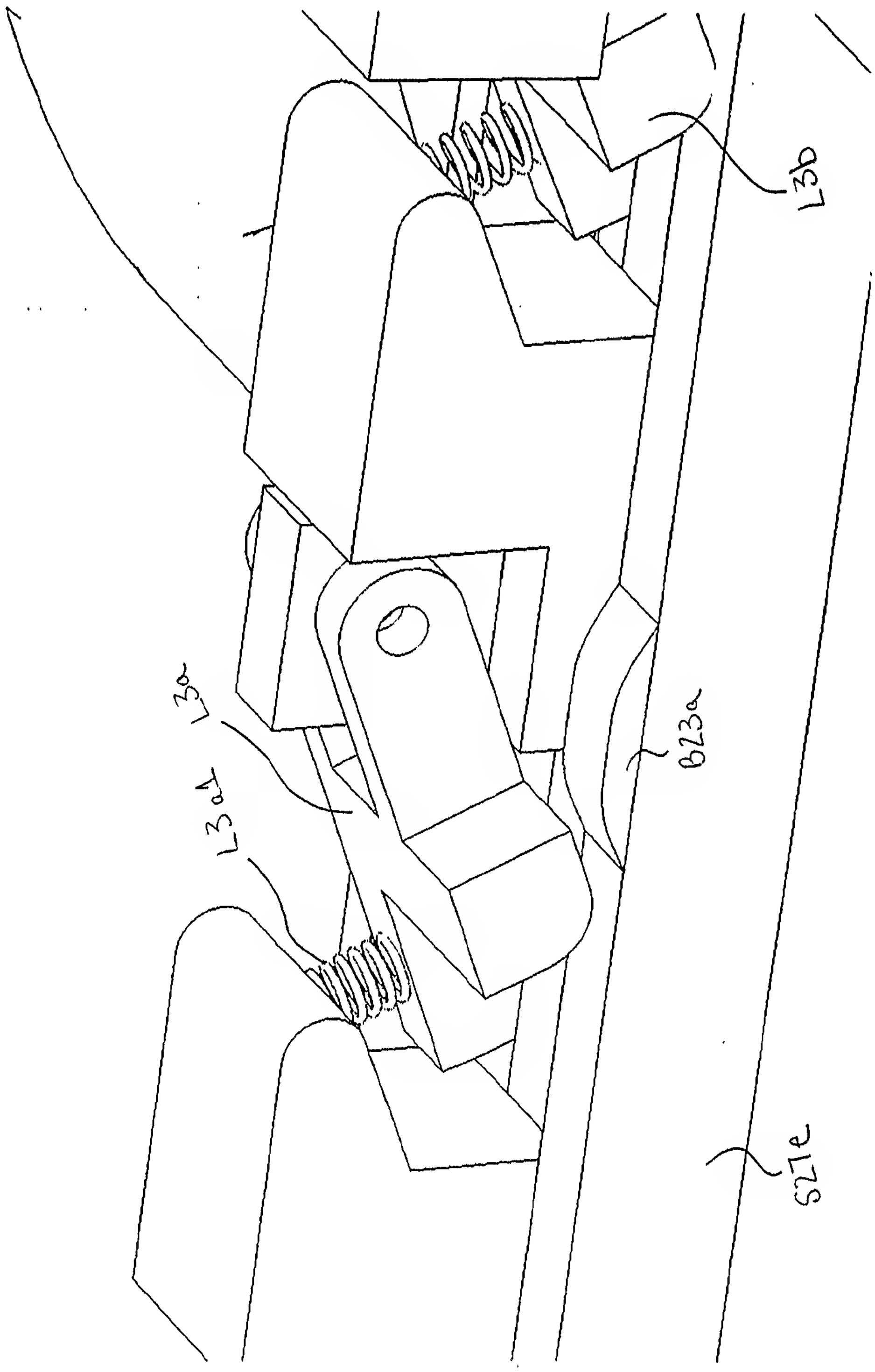


FIG. B23

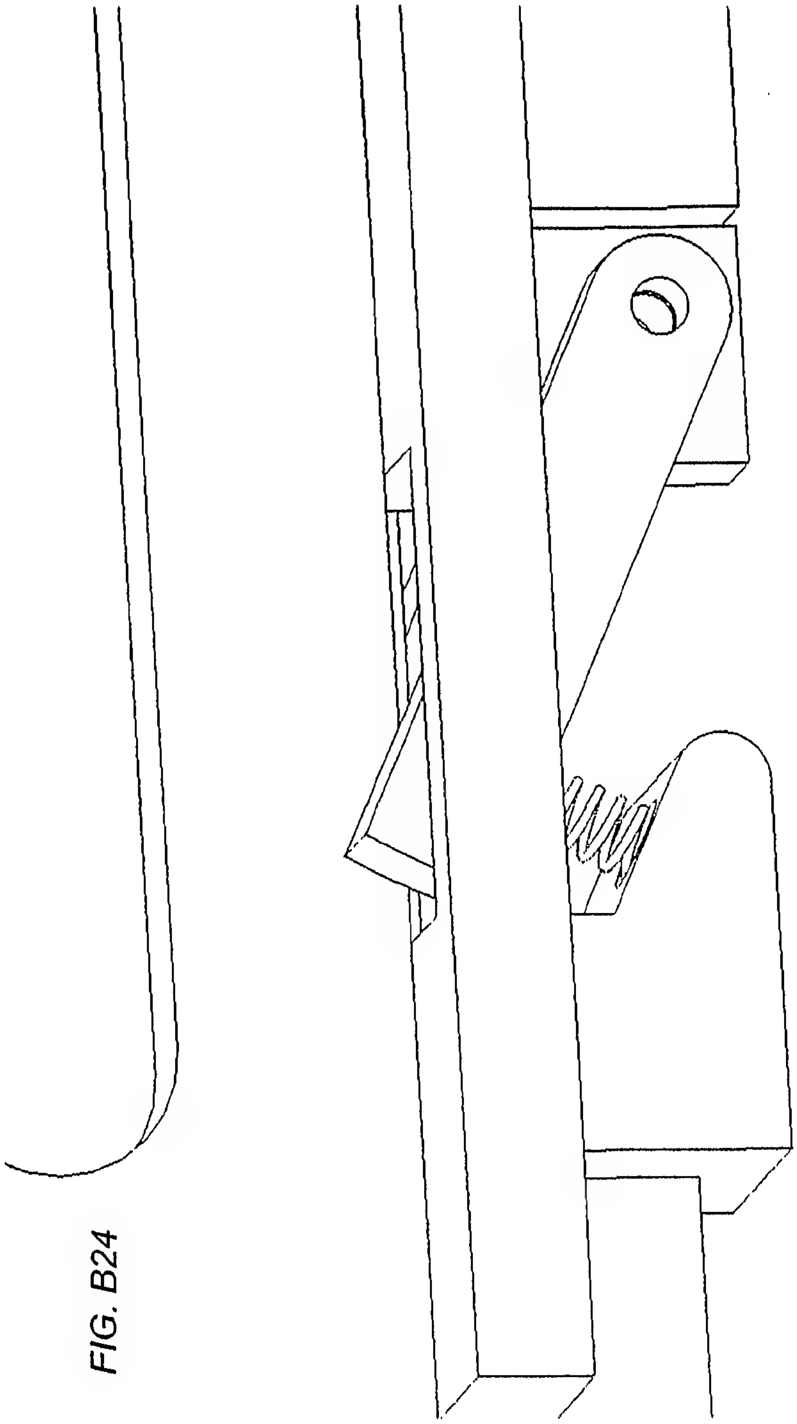
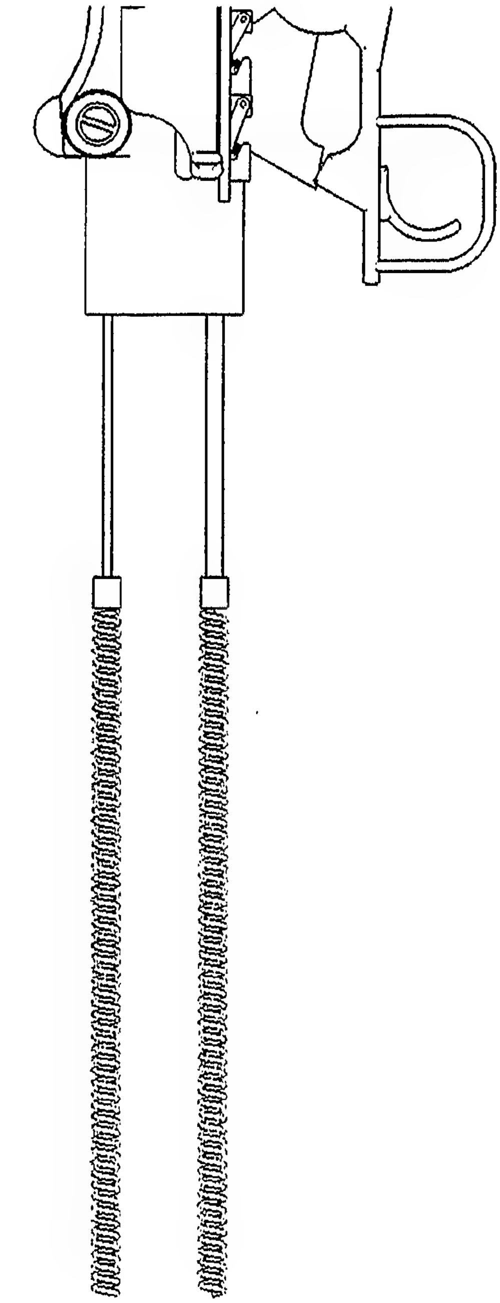


FIG. B24



25 / 200

FIG. B25

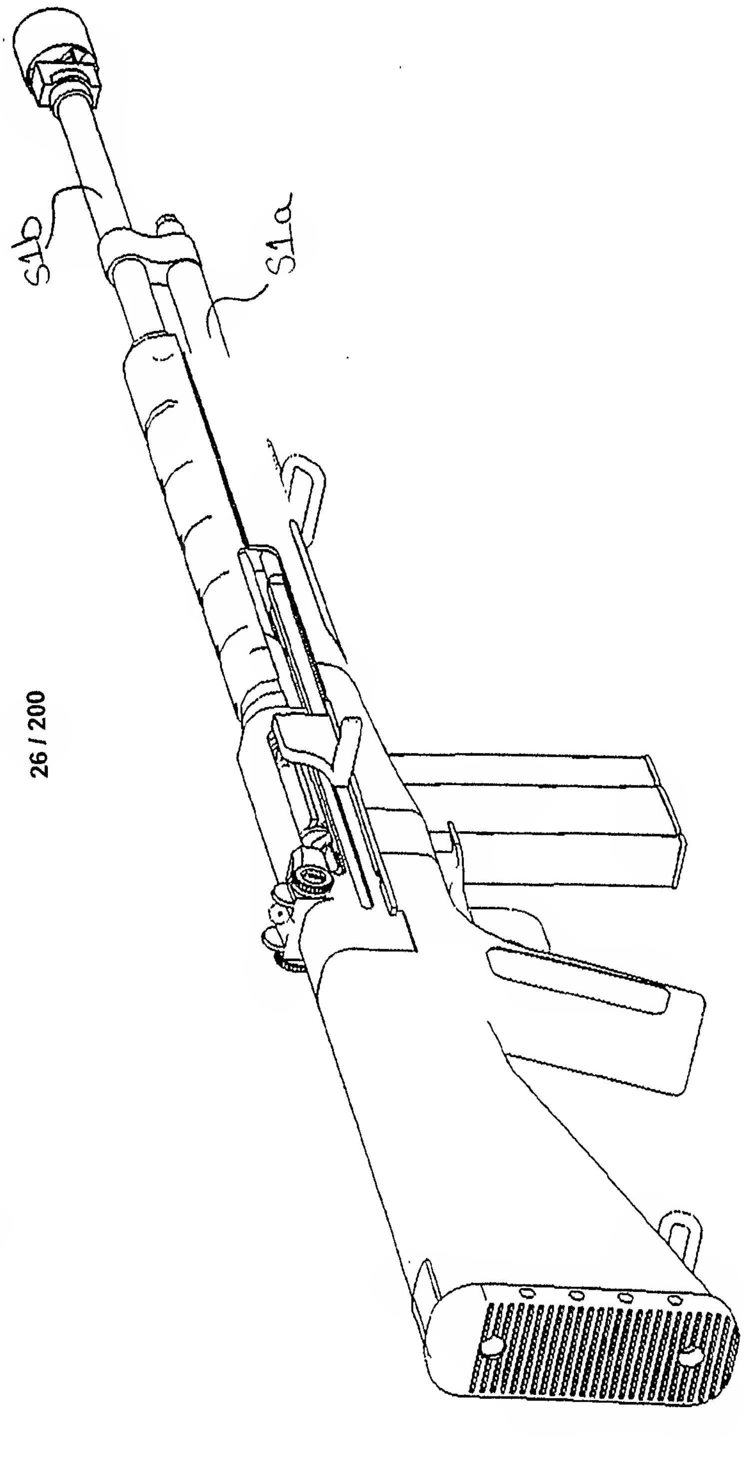
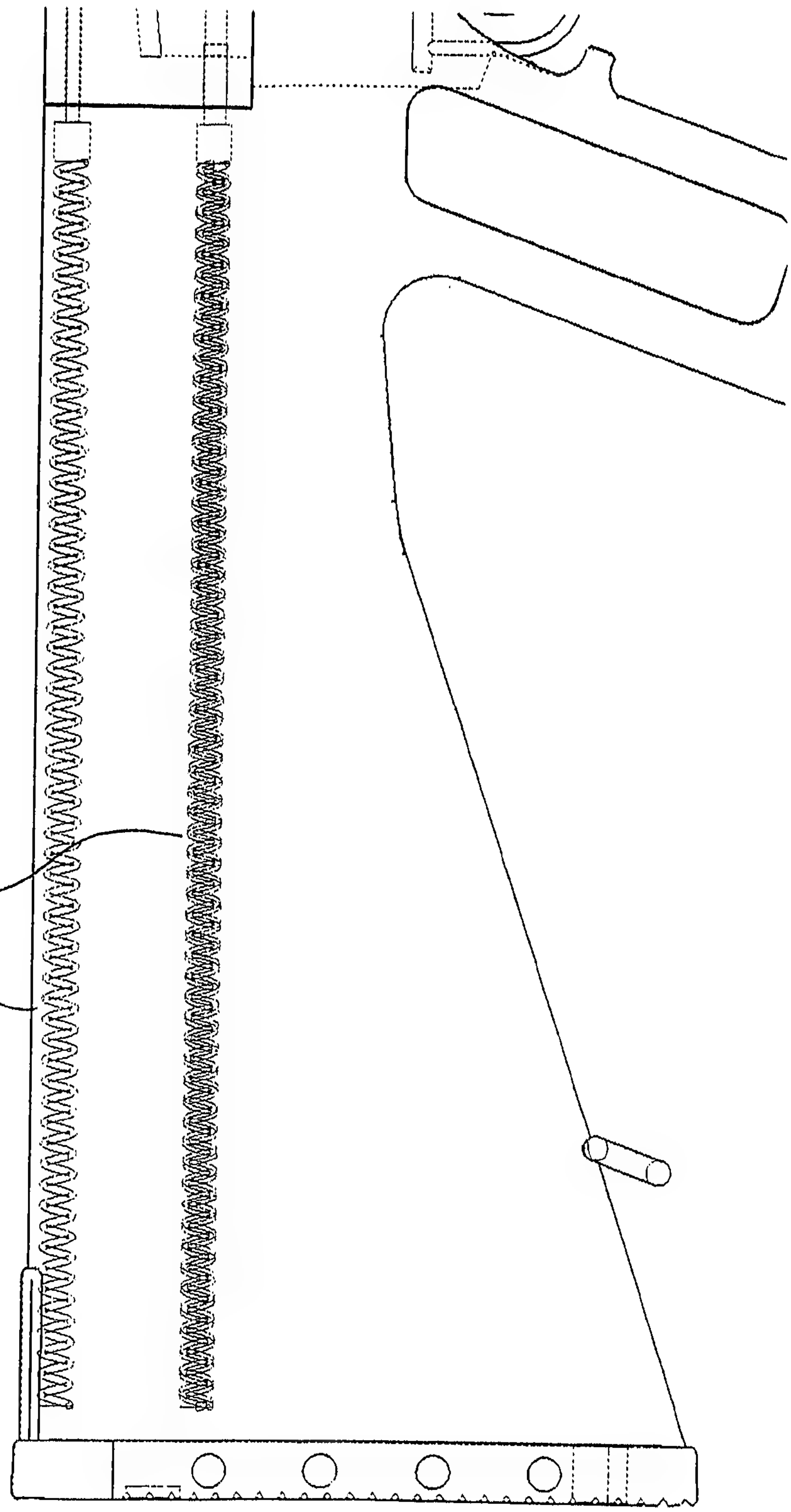


FIG. C1

FIG. C5



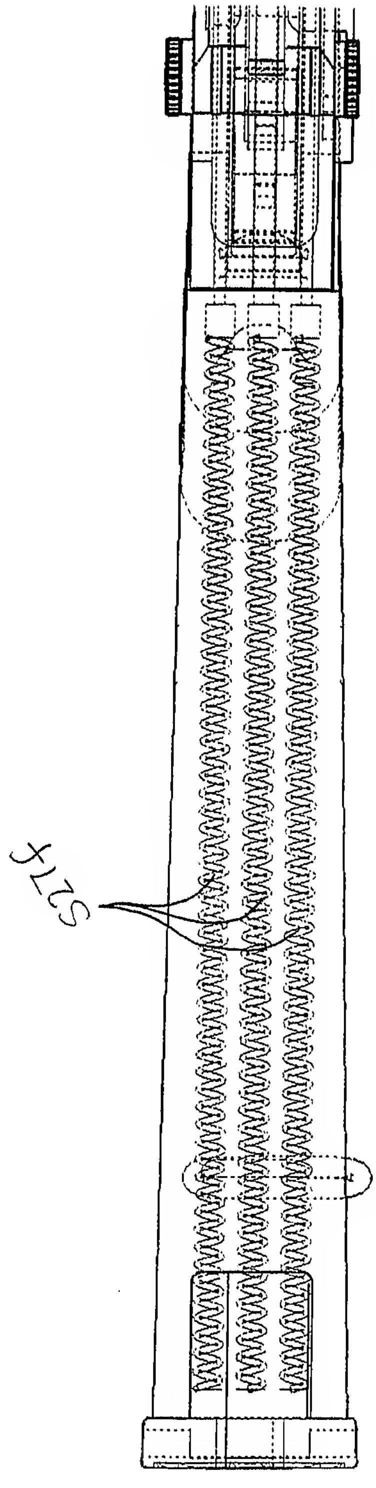


FIG. C6

FIG. C7

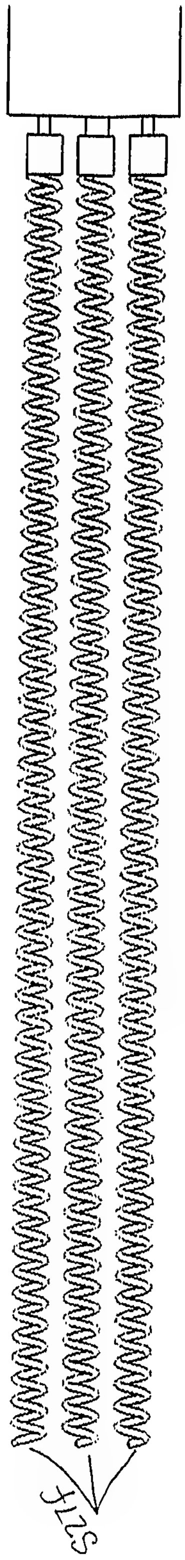
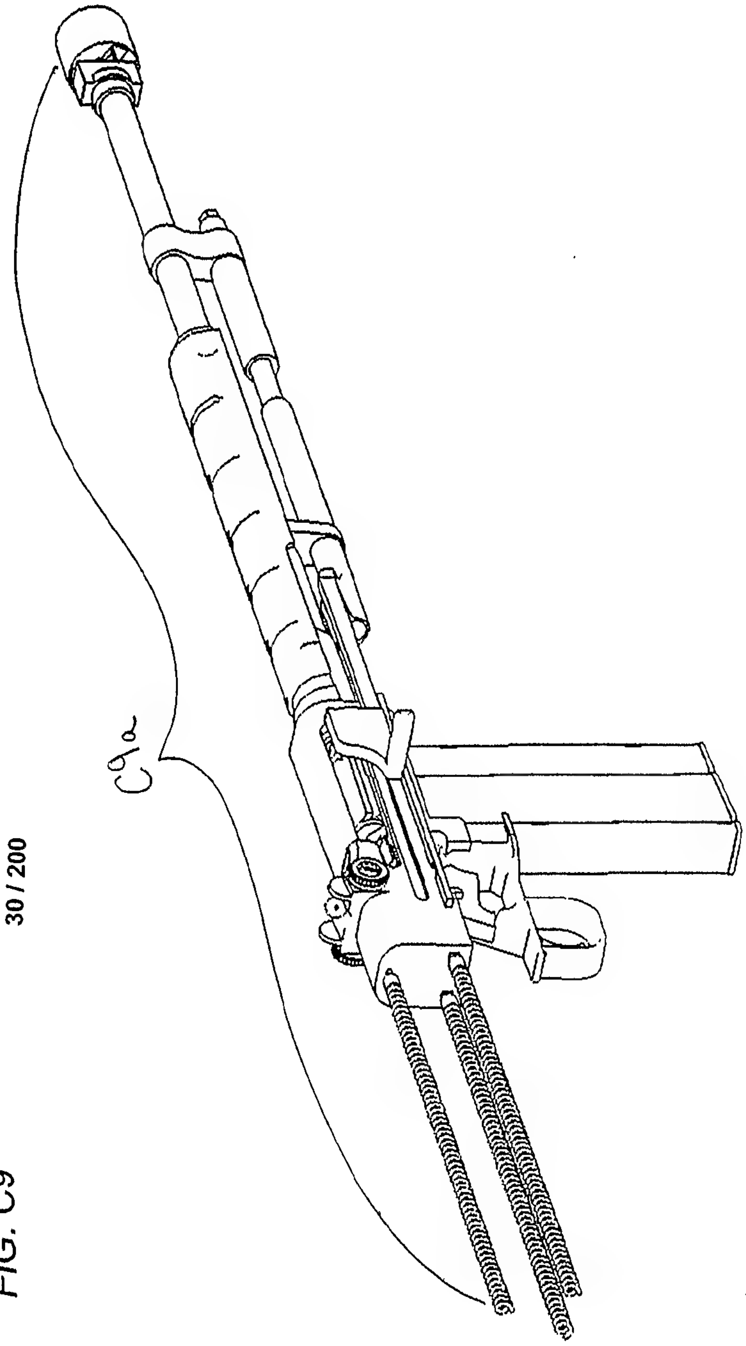


FIG. C9



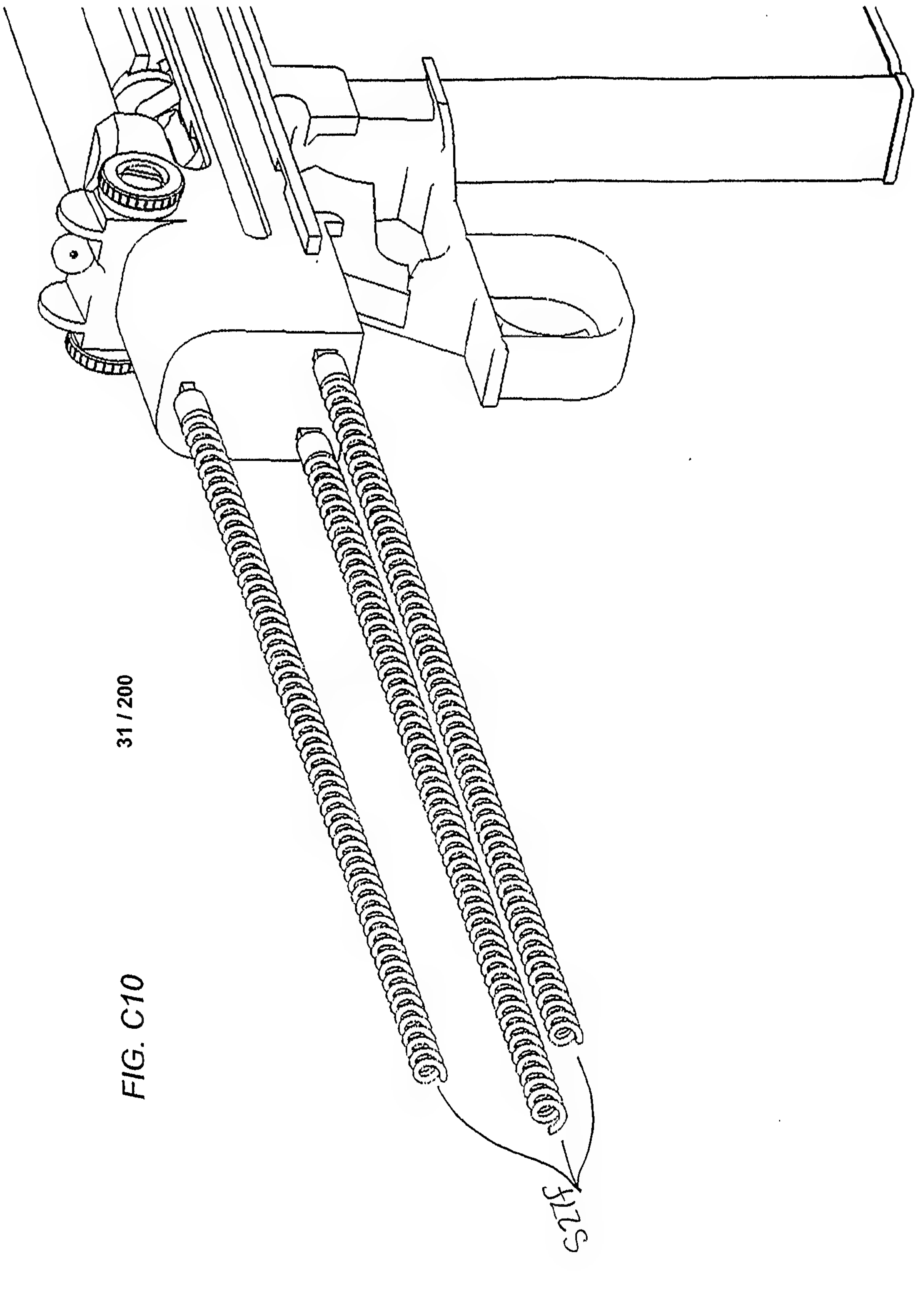


FIG. C10

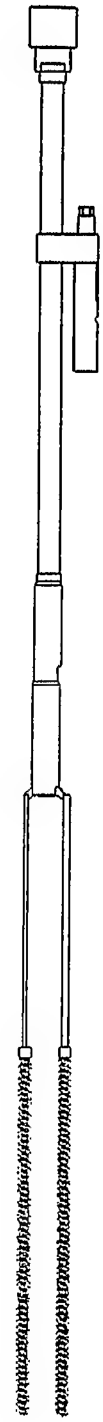


FIG. C12

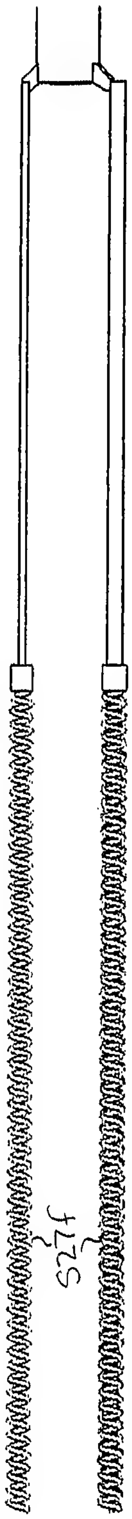


FIG. C13

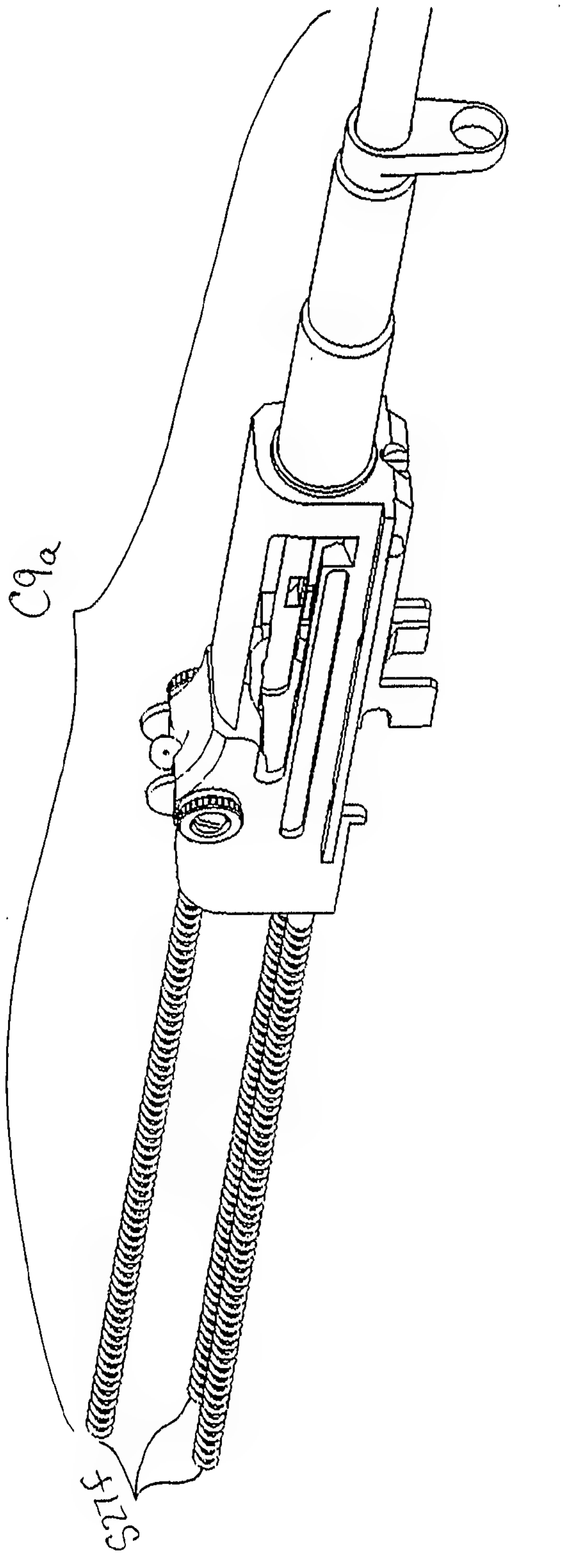


FIG. C15

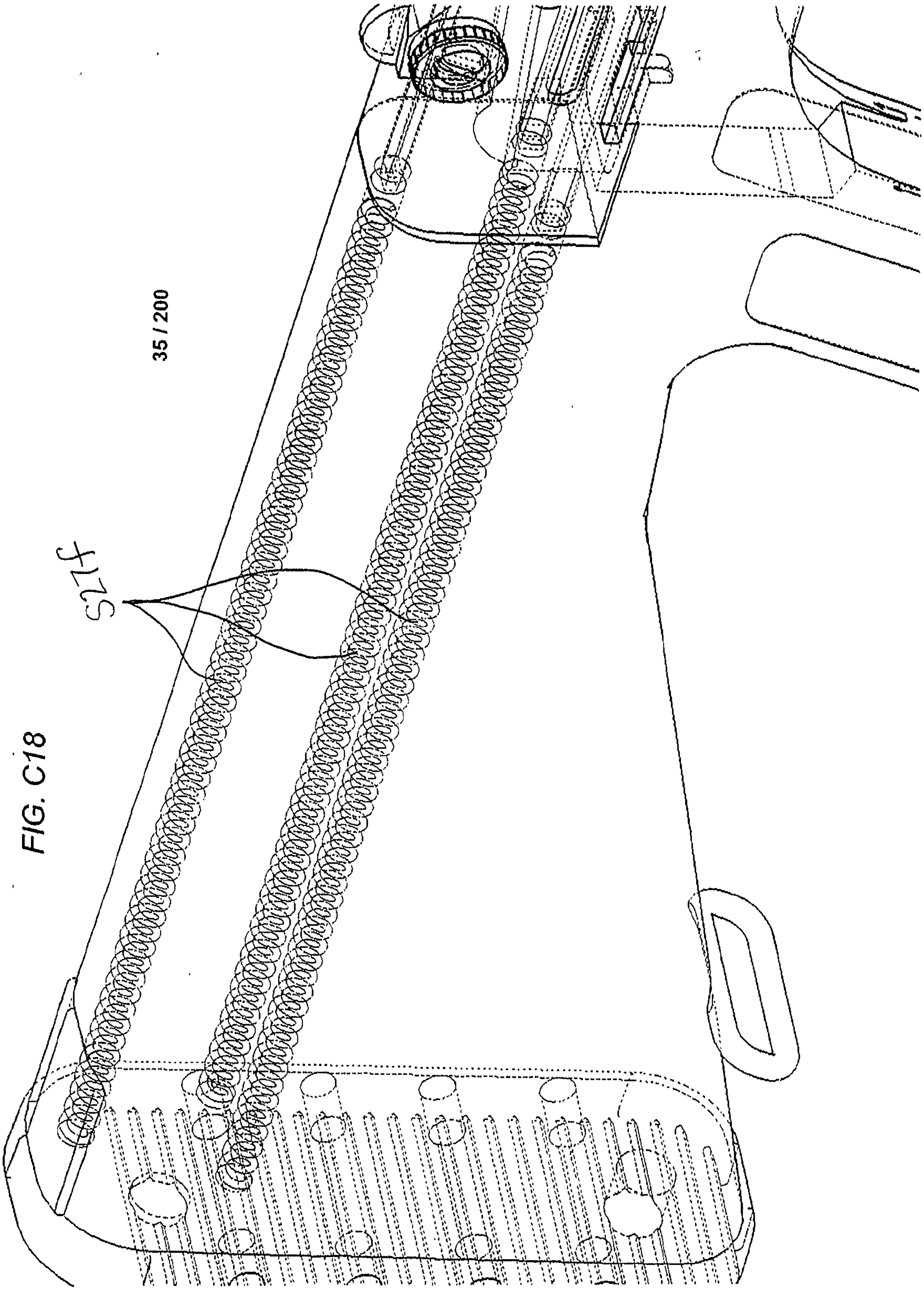


FIG. C18

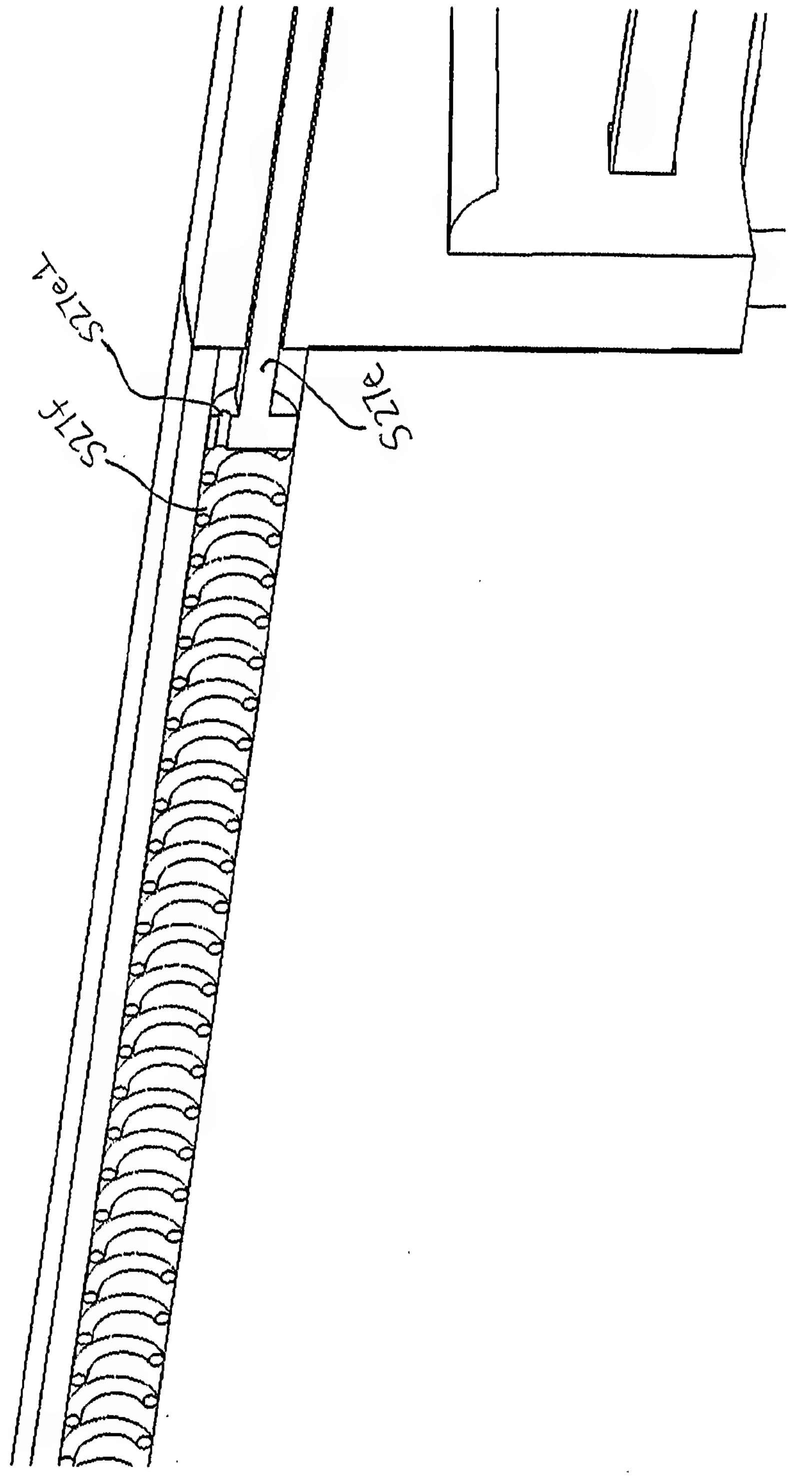


FIG. C19

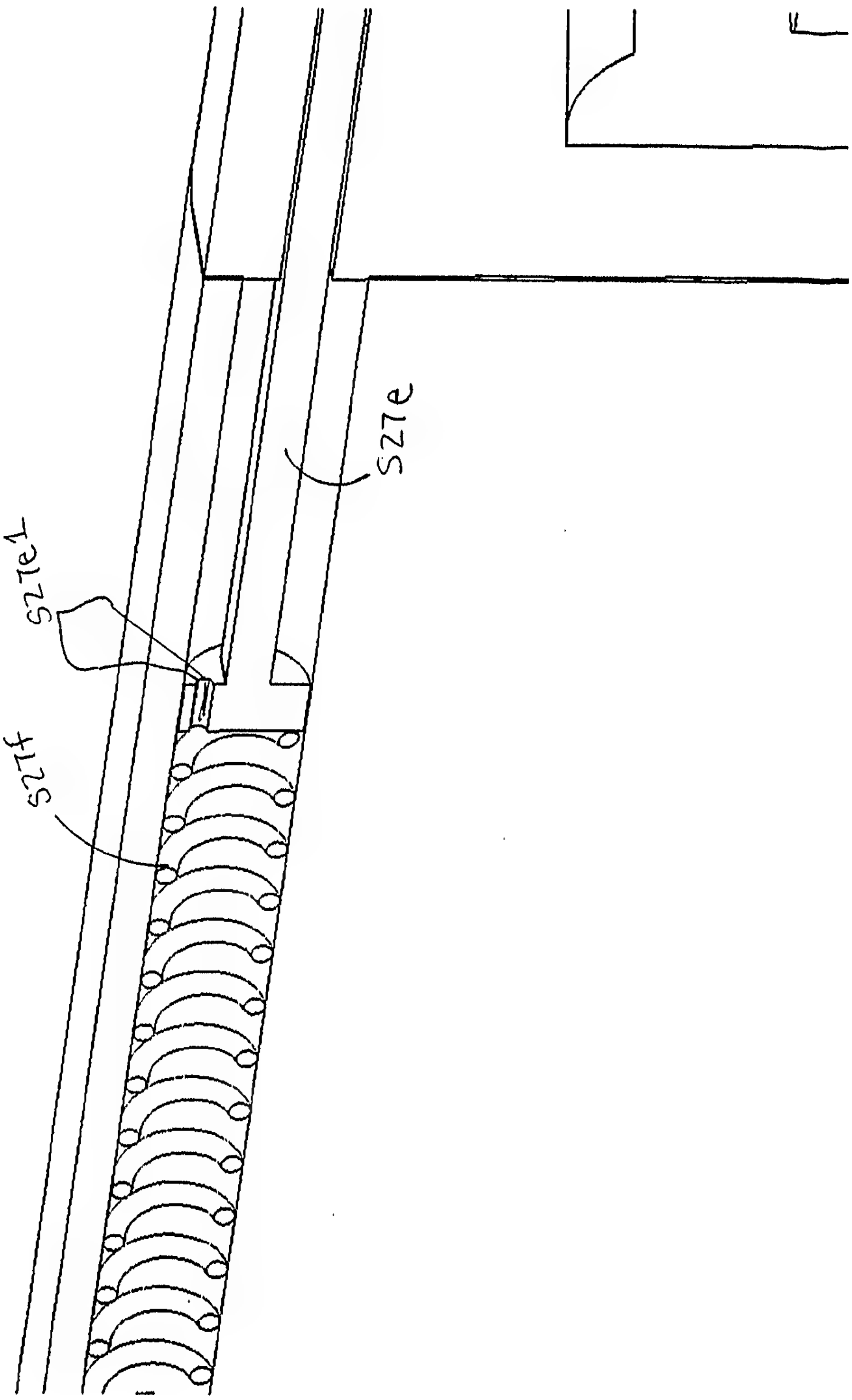


FIG. C20

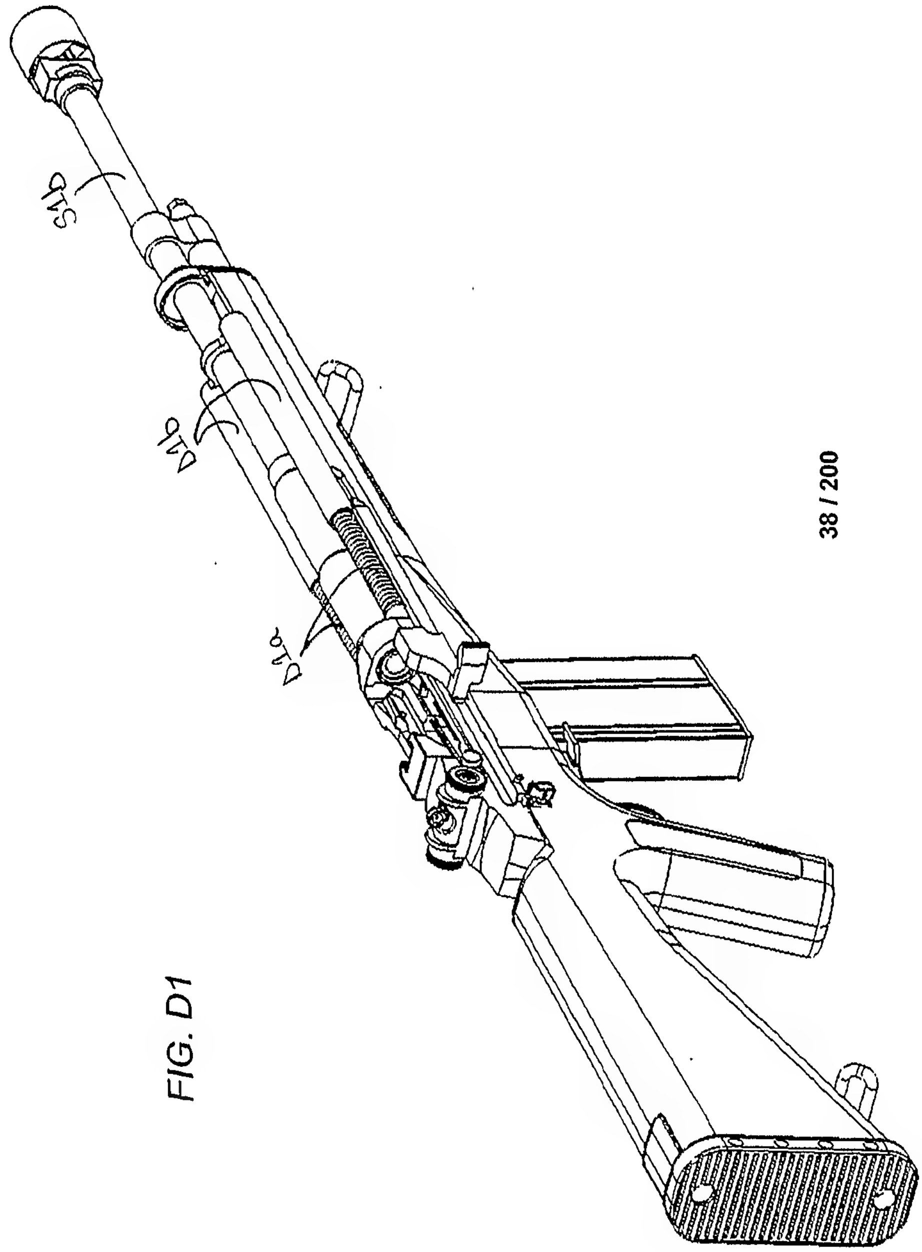


FIG. D1

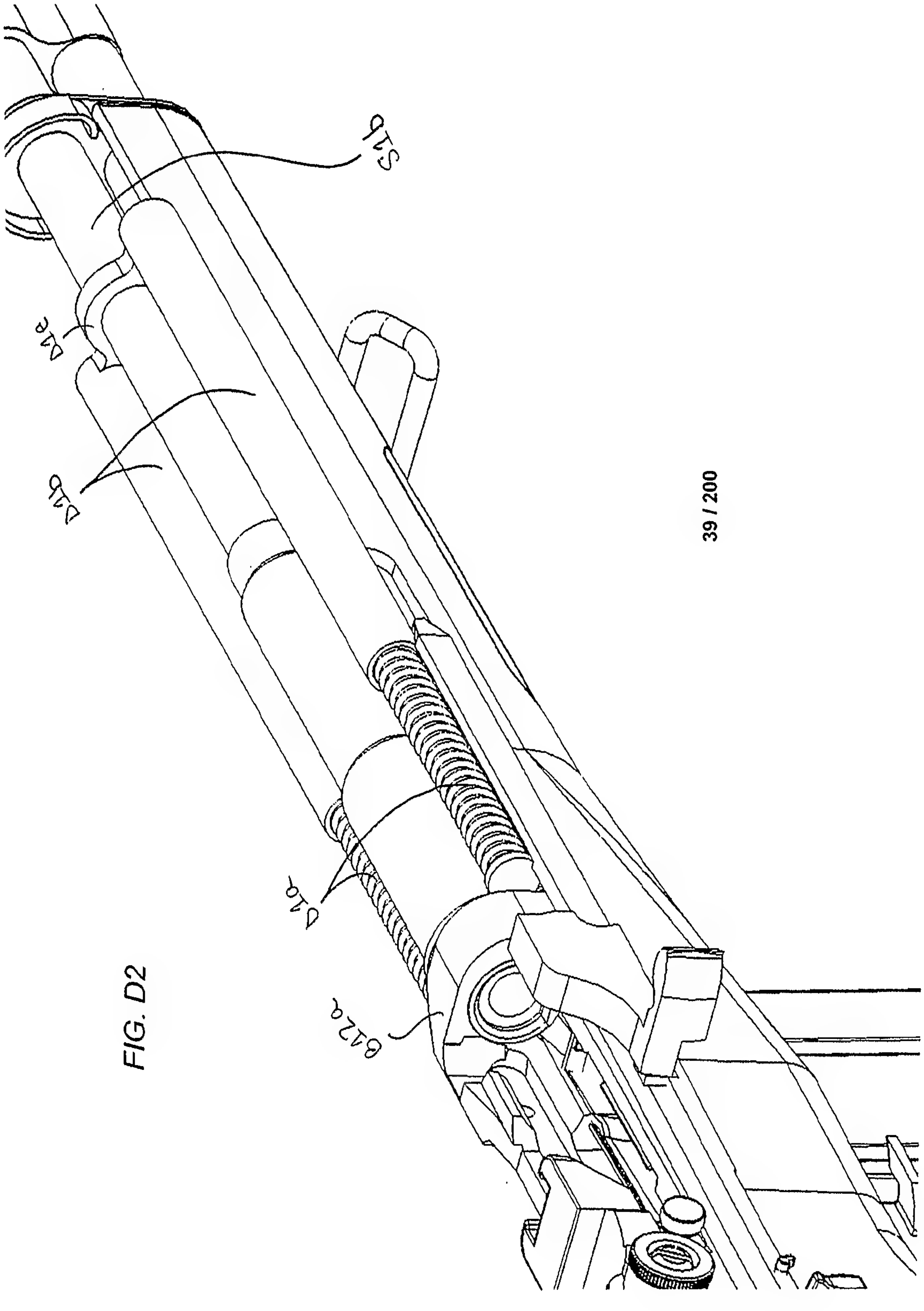


FIG. D2

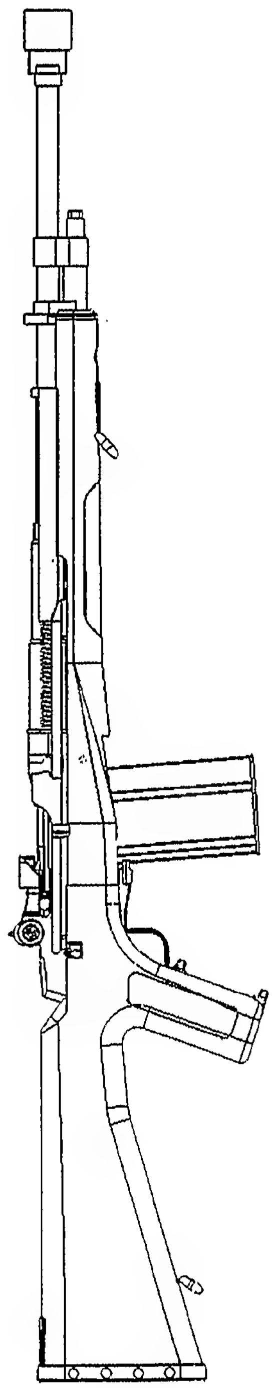


FIG. D3

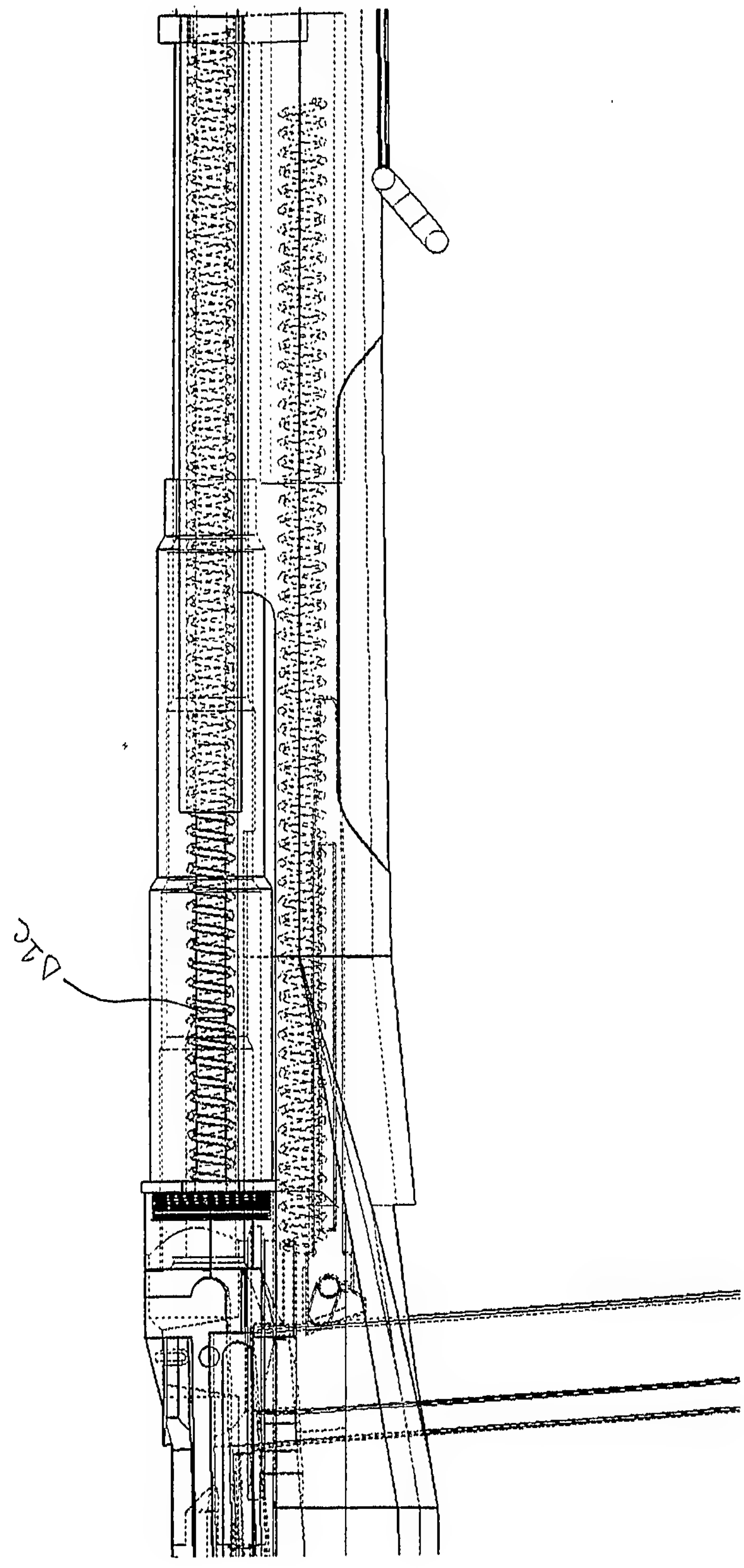


FIG. D4

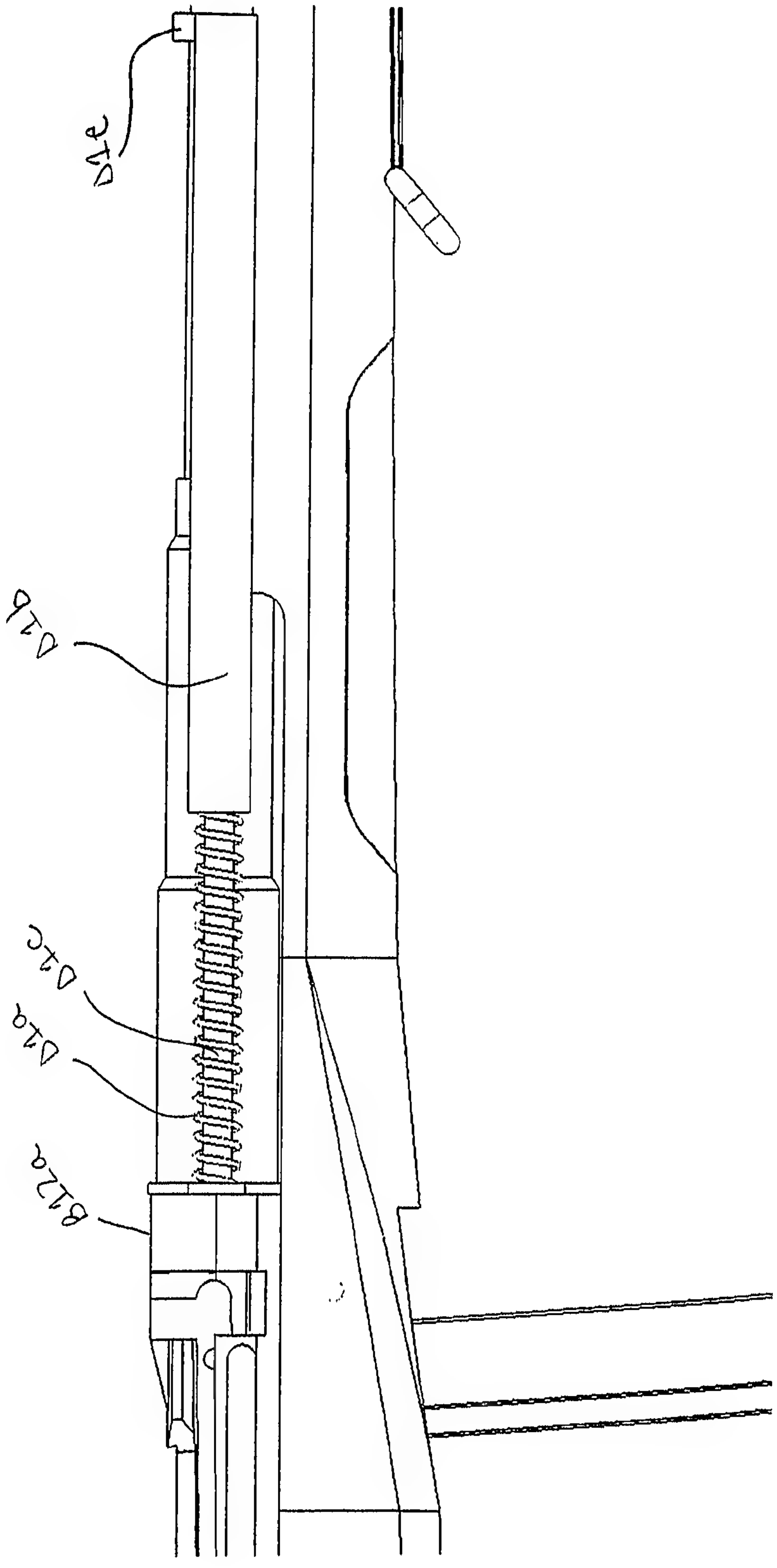


FIG. D5

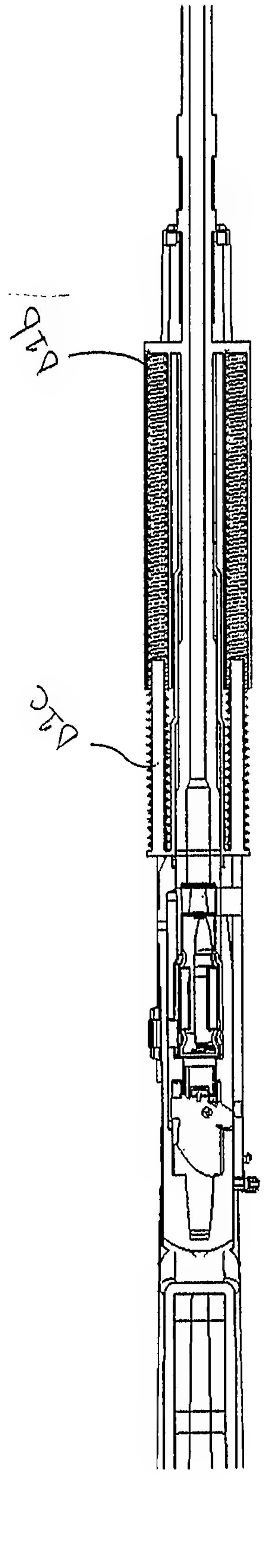


FIG. D6

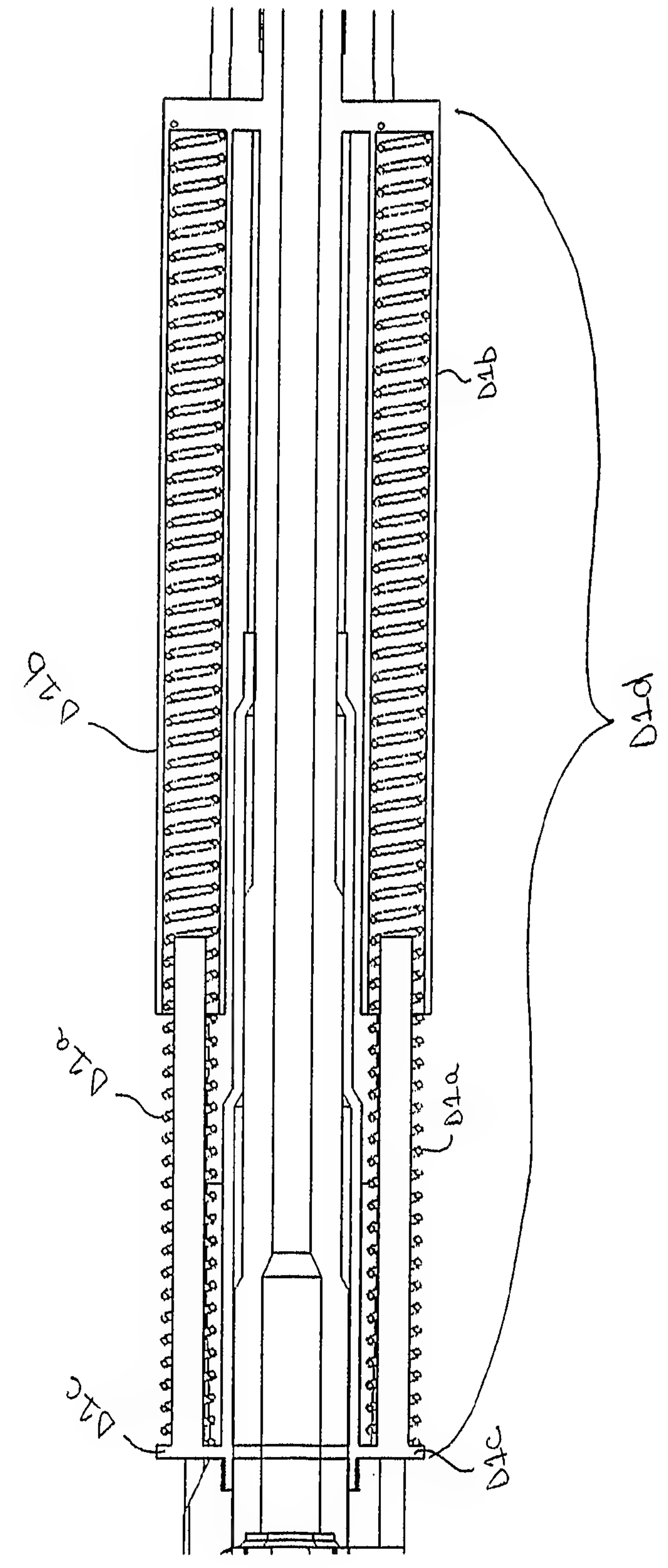


FIG. D7

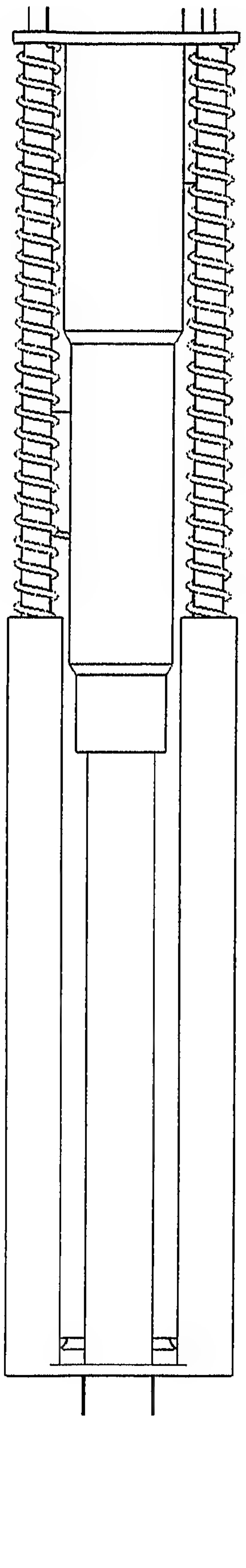


FIG. D8

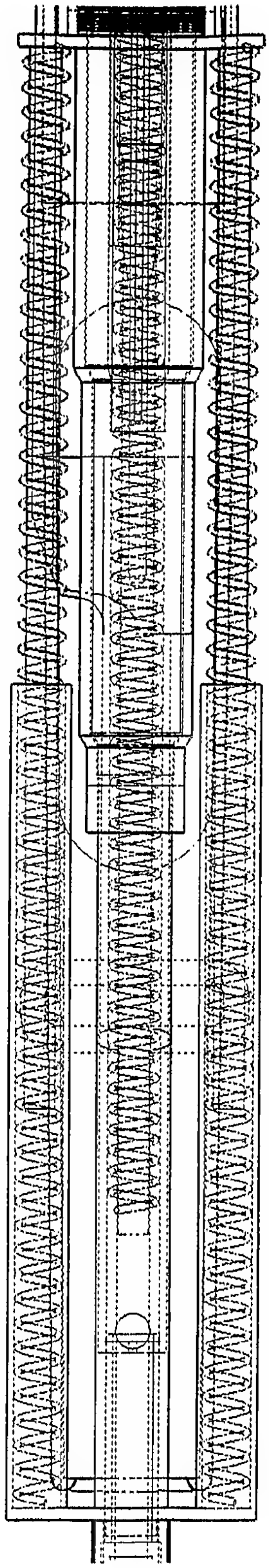


FIG. D9

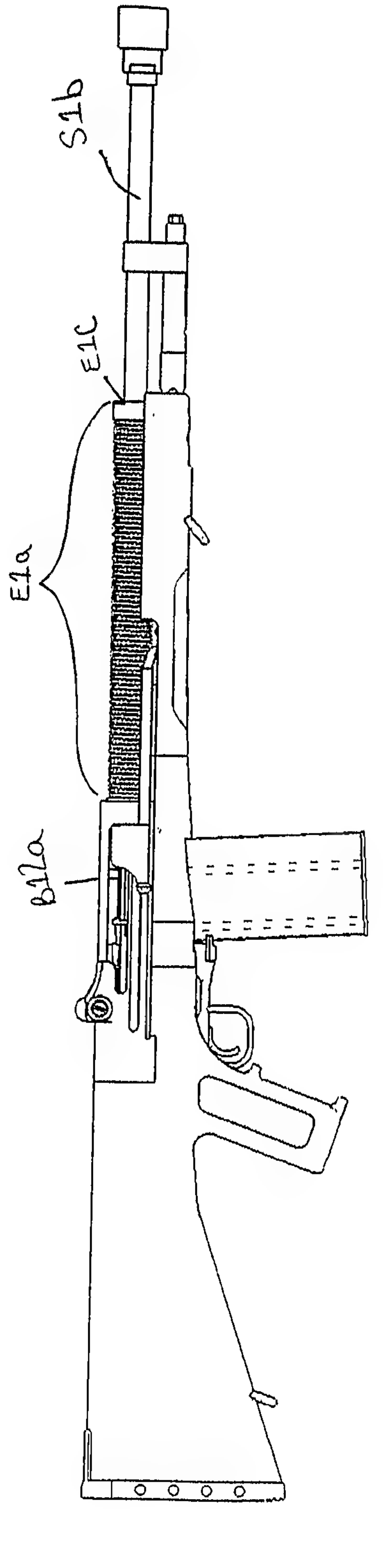
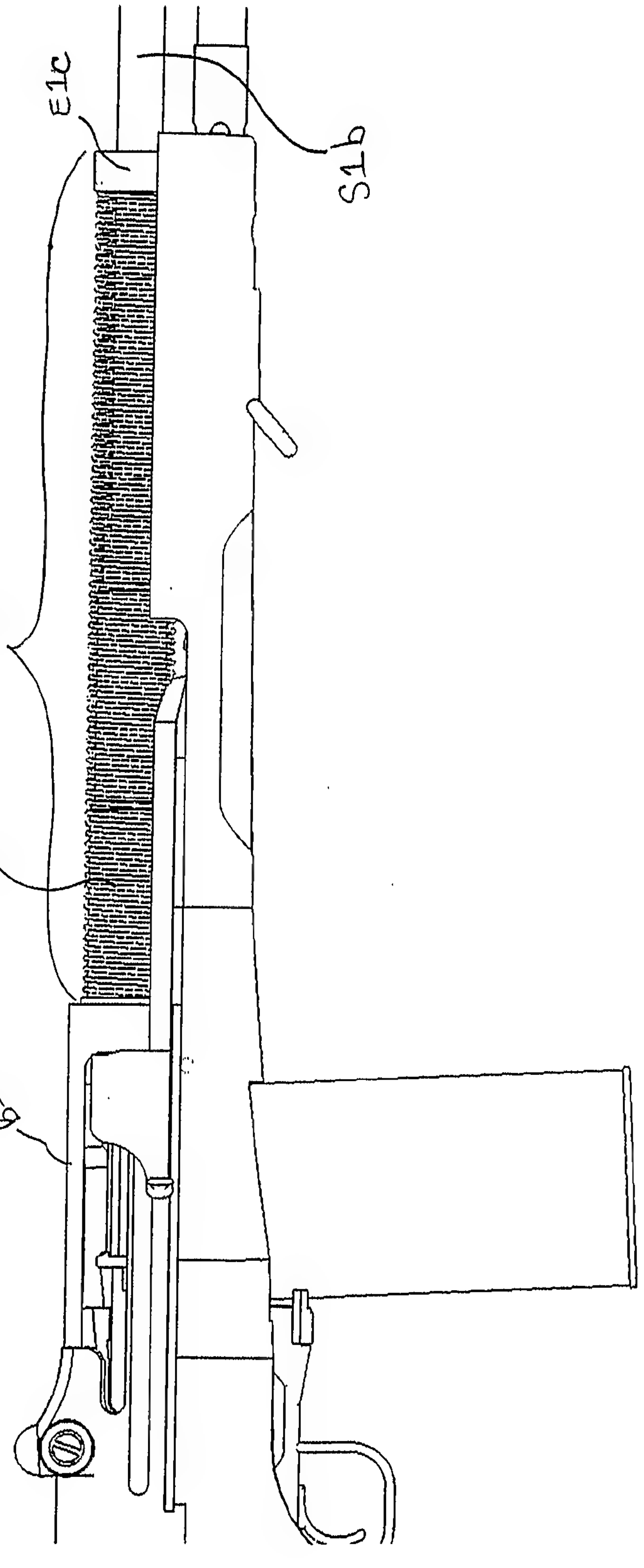


FIG. E1

FIG. E2



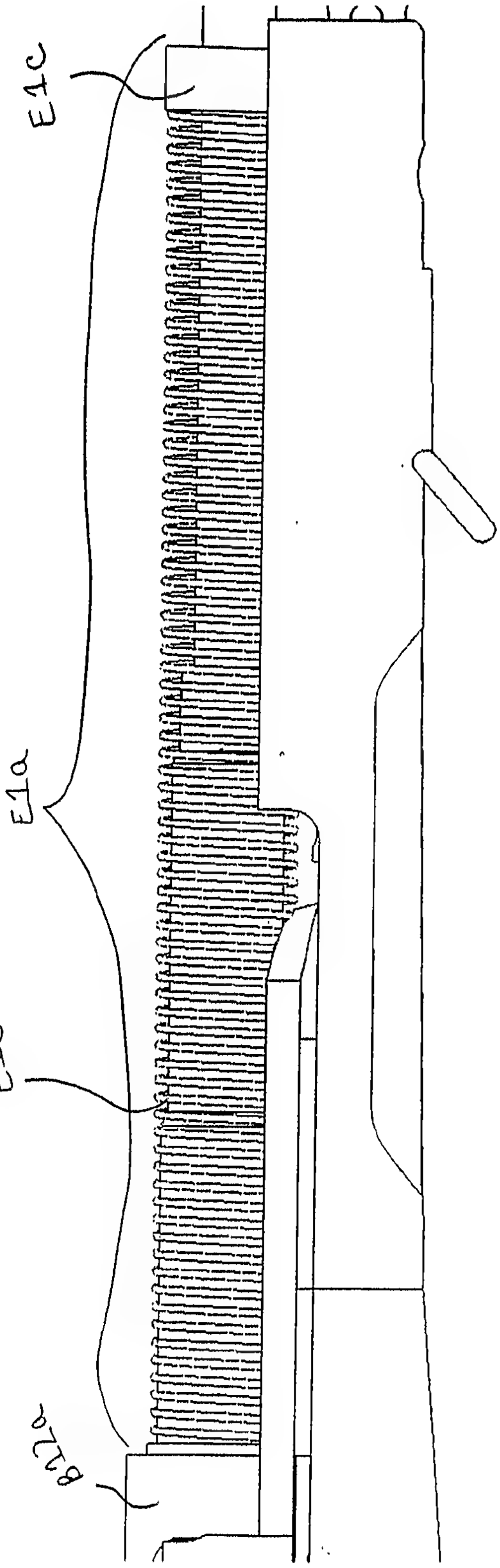
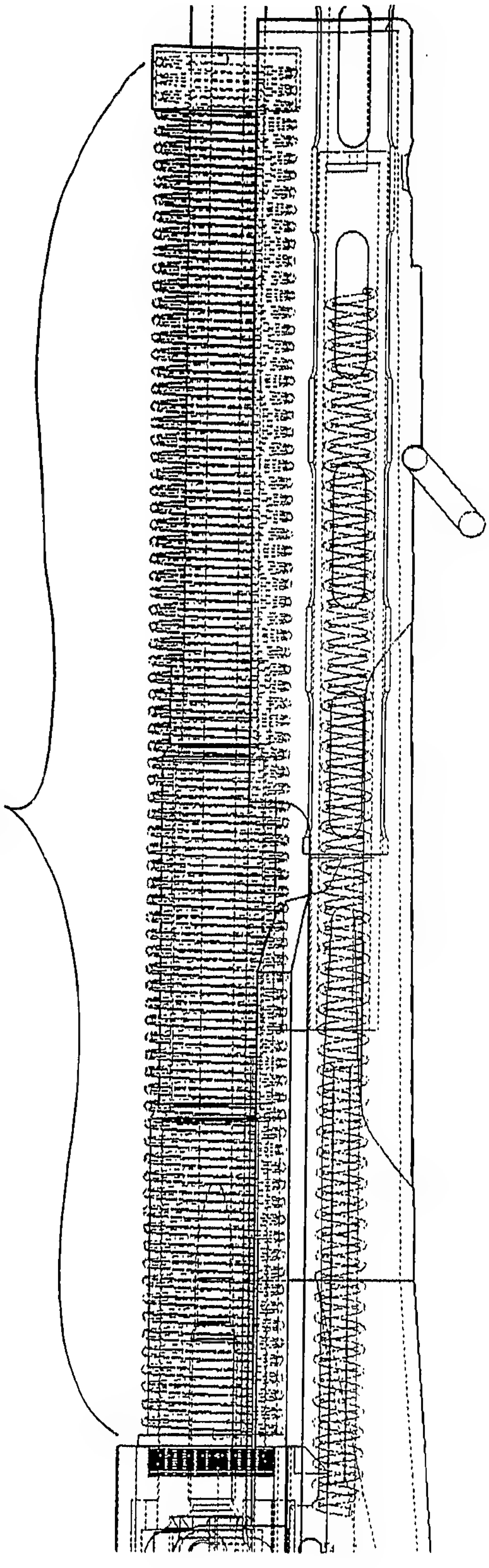


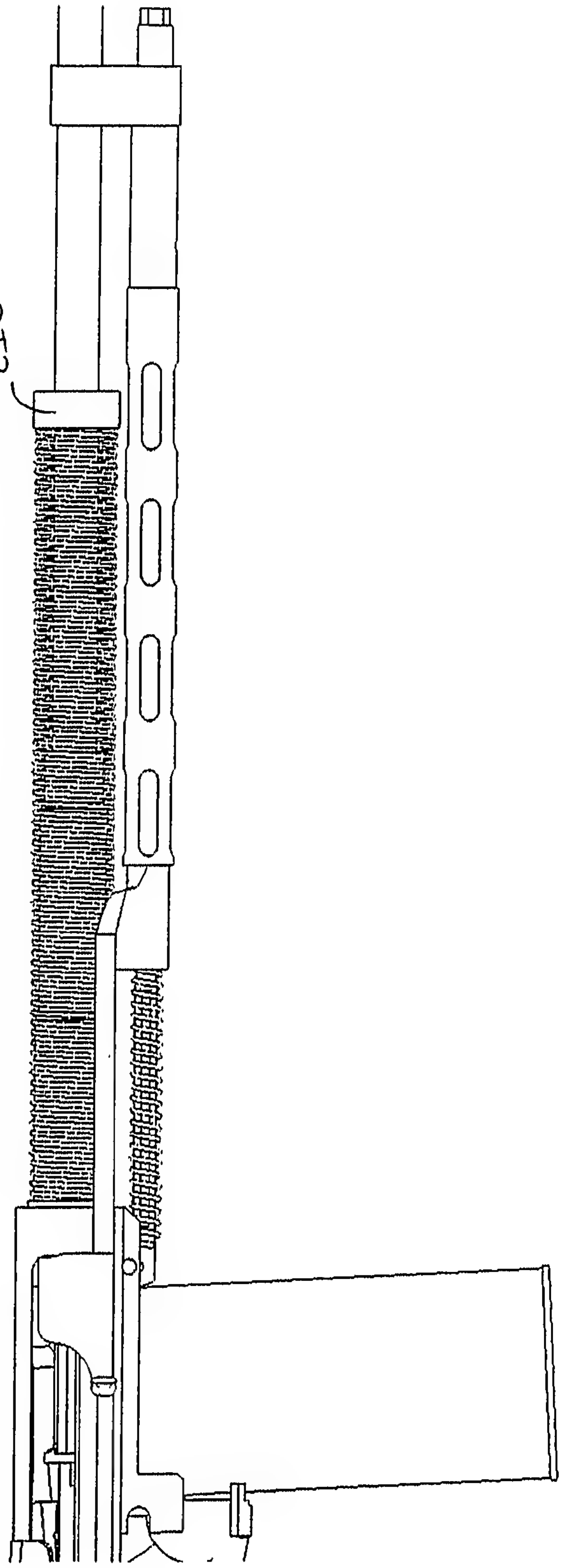
FIG. E3

FIG. E4



E1a

FIG. E5



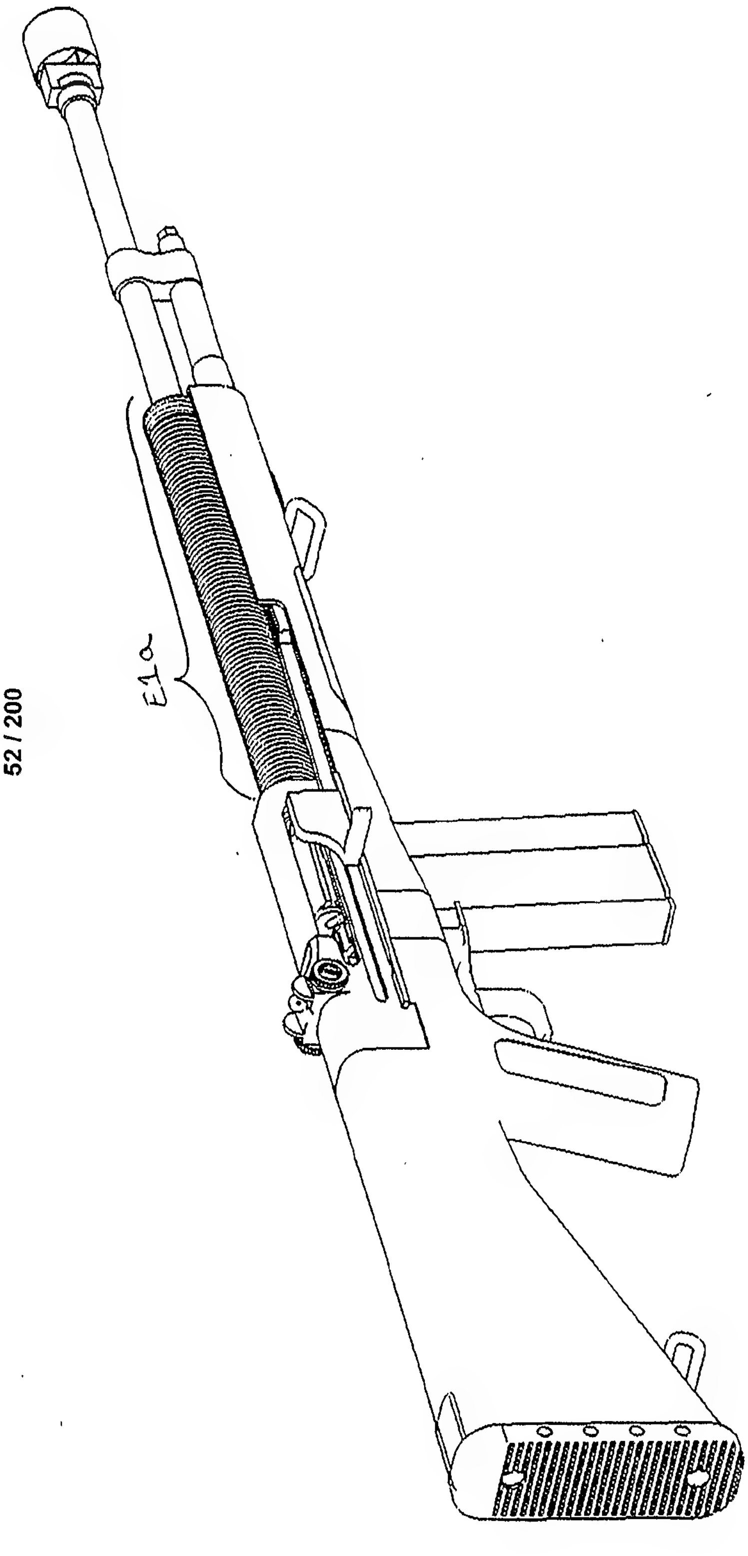


FIG. E6

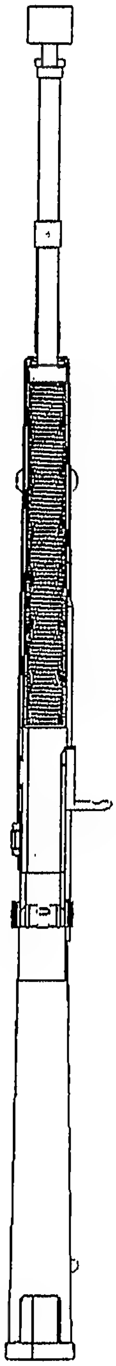
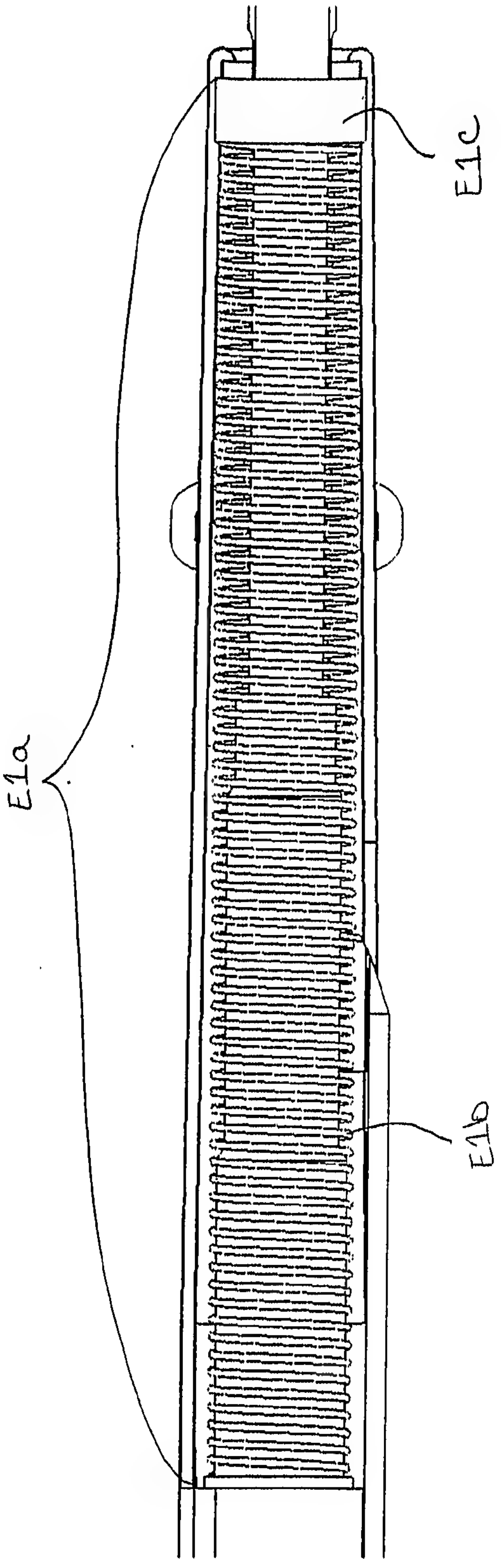


FIG. E7

FIG. E8



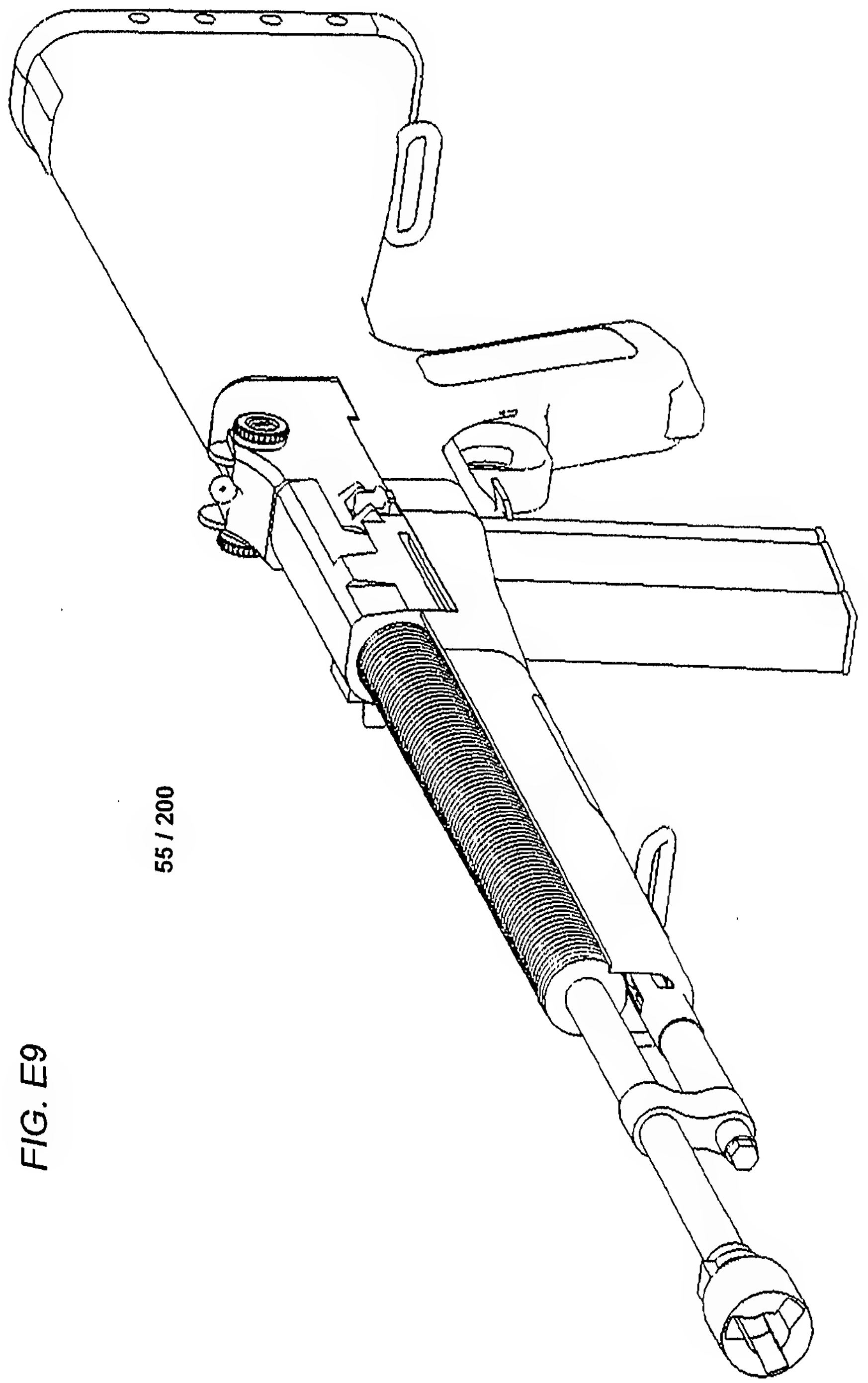


FIG. E9

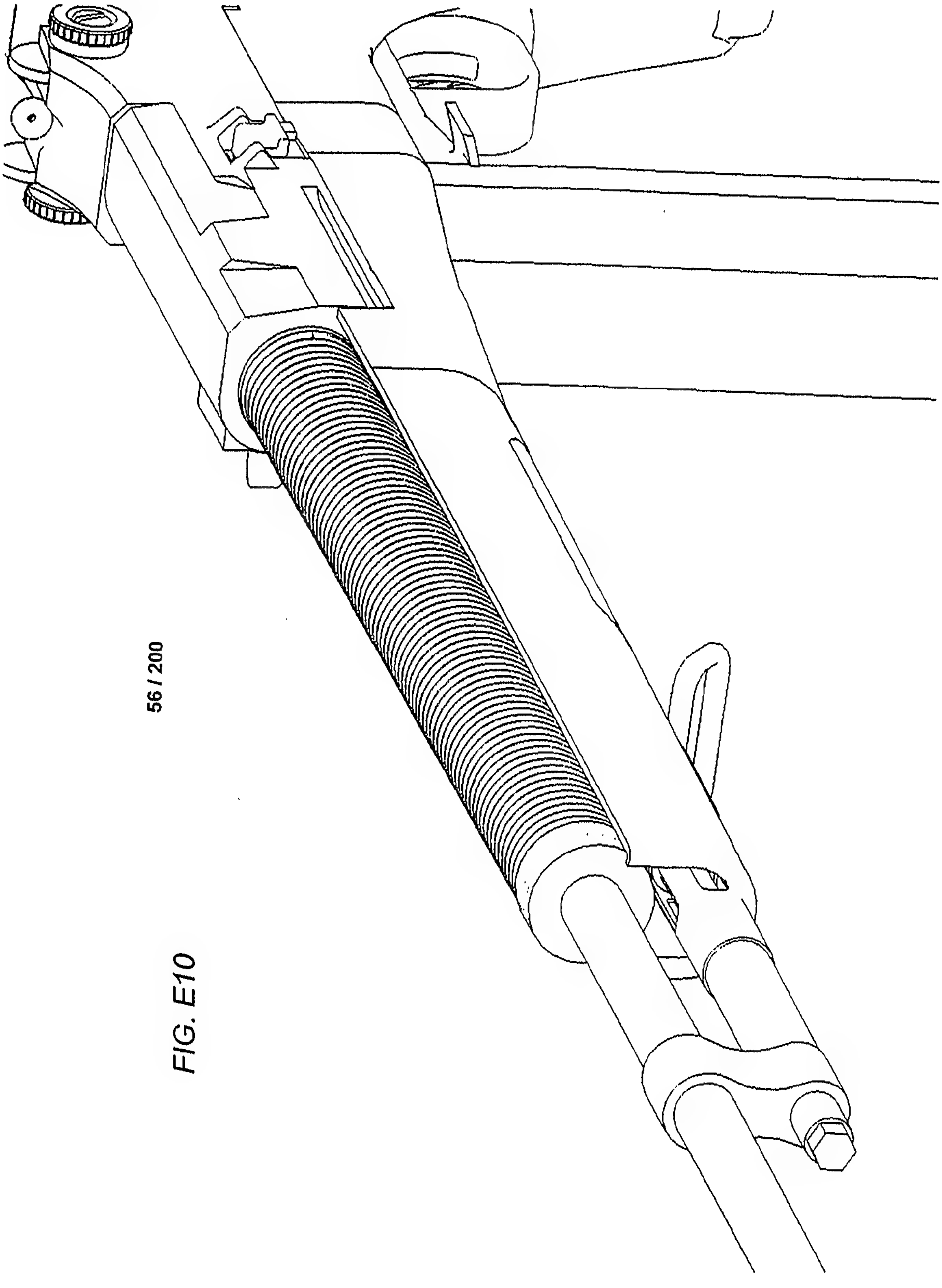


FIG. E10

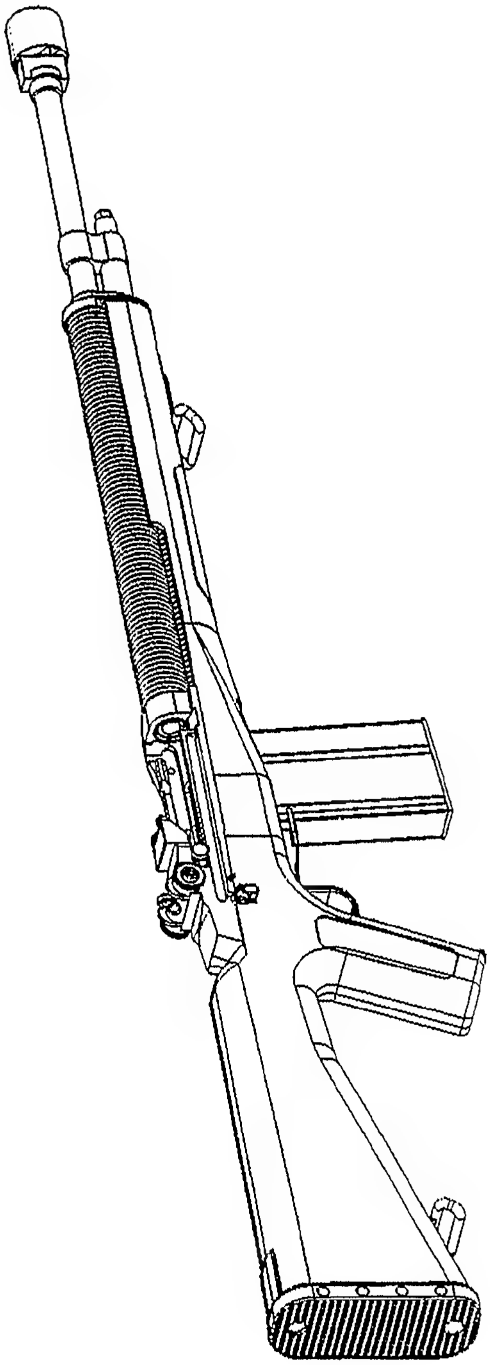


FIG. E11

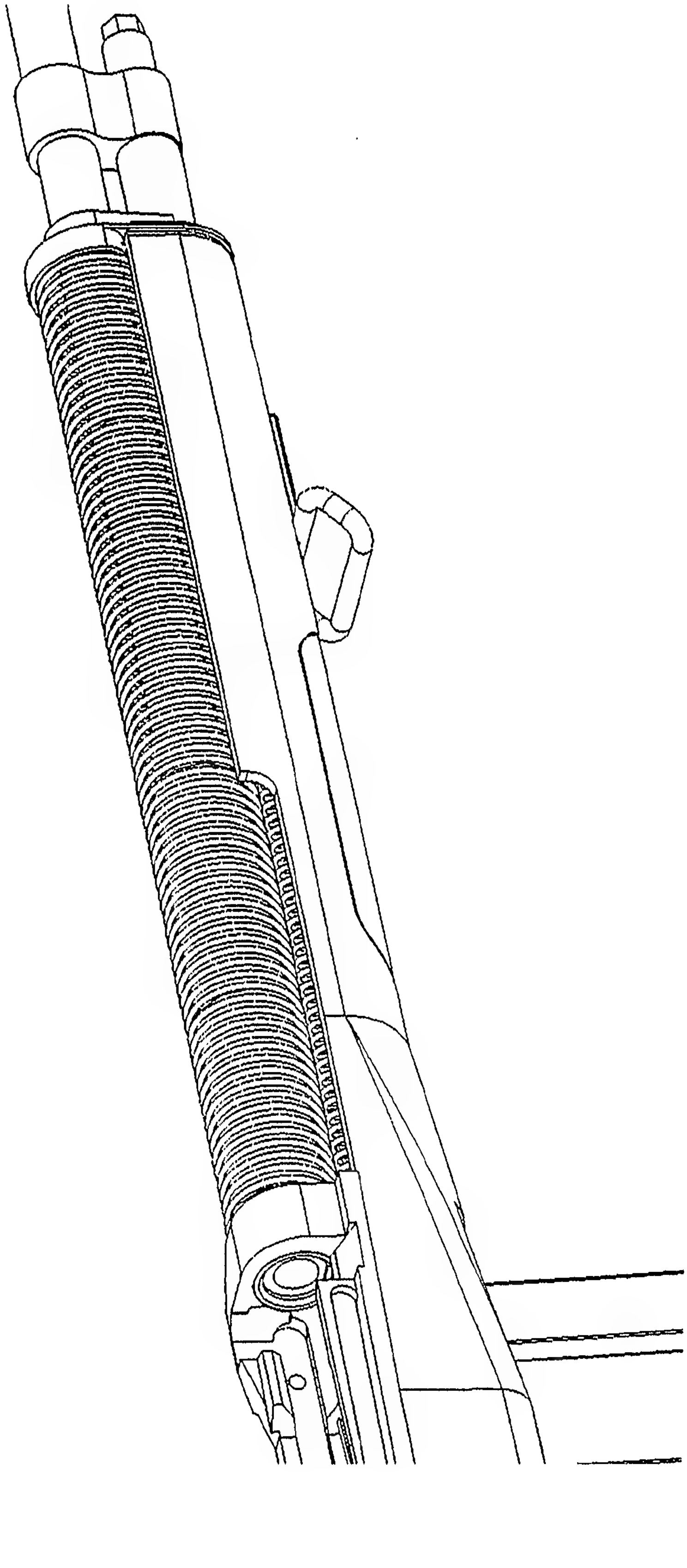


FIG. E12

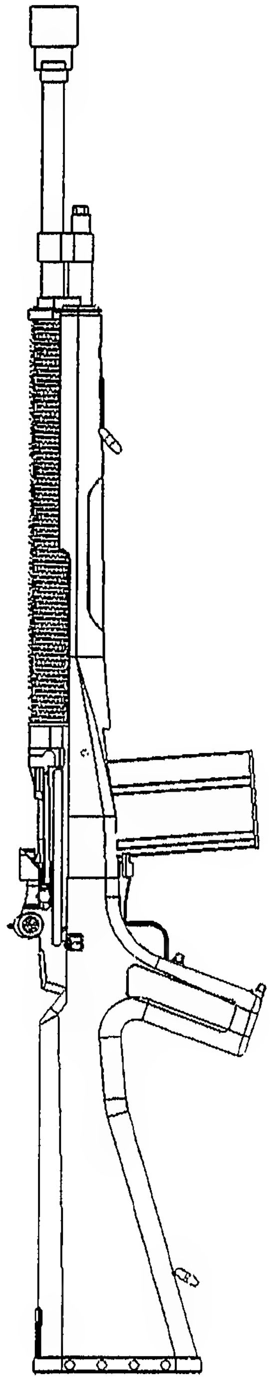


FIG. E13

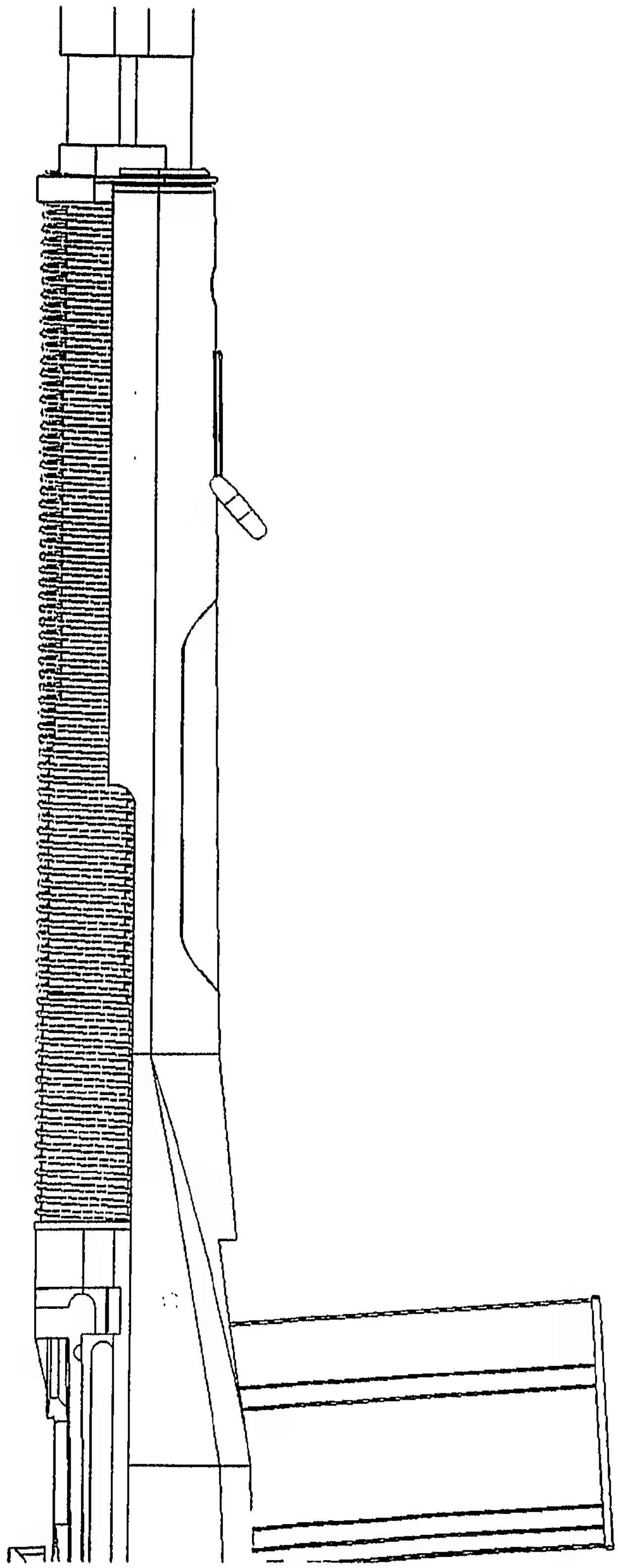


FIG. E14

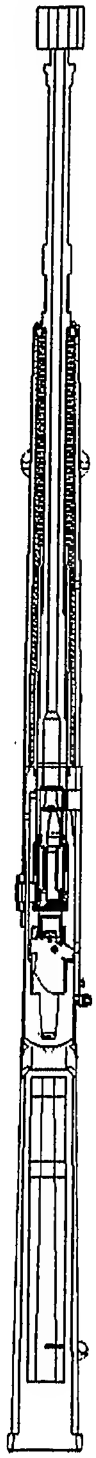


FIG. E15

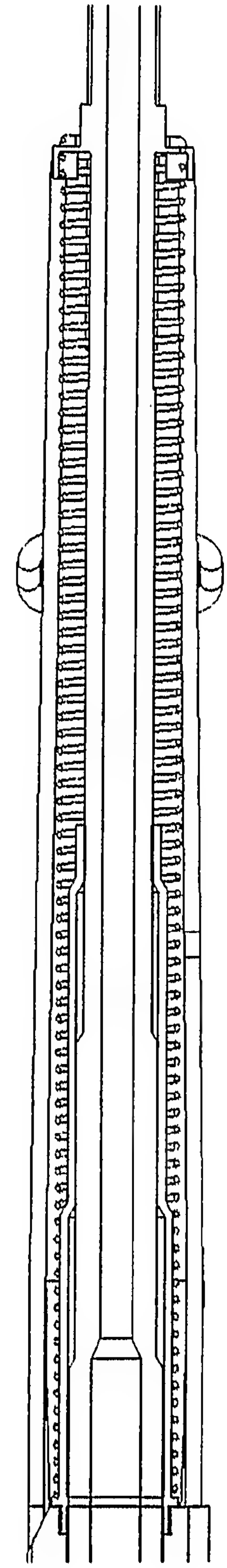


FIG. E16

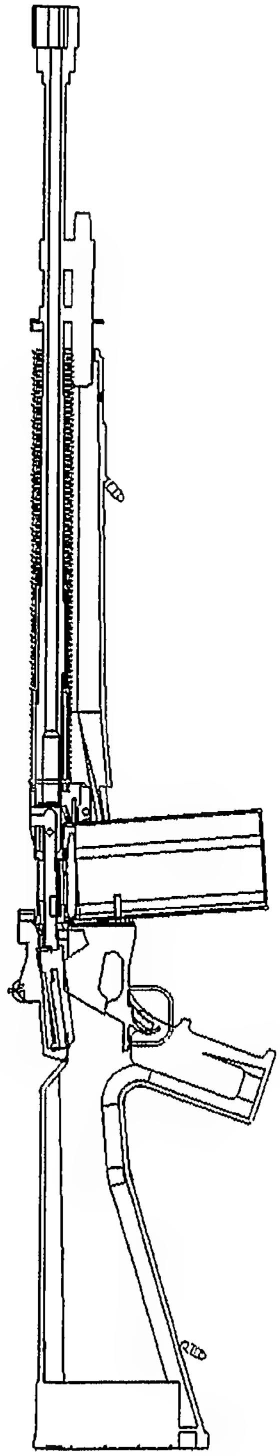


FIG. E17

64 / 200

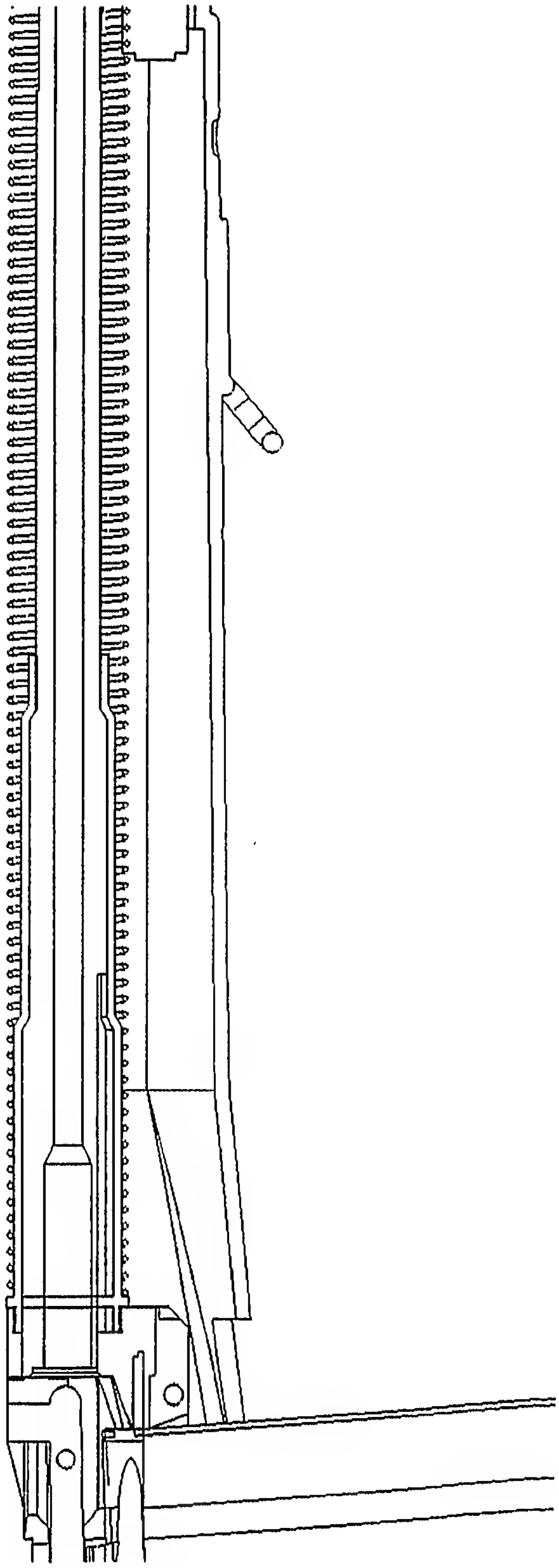


FIG. E18

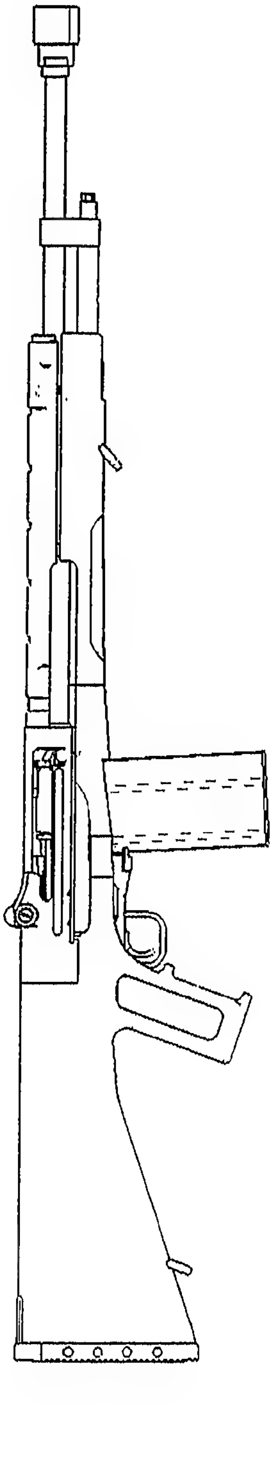


FIG. F1

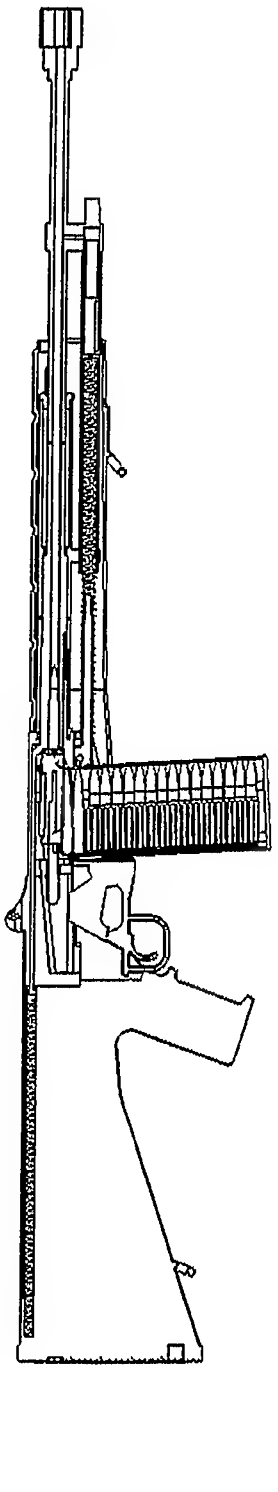


FIG. F2

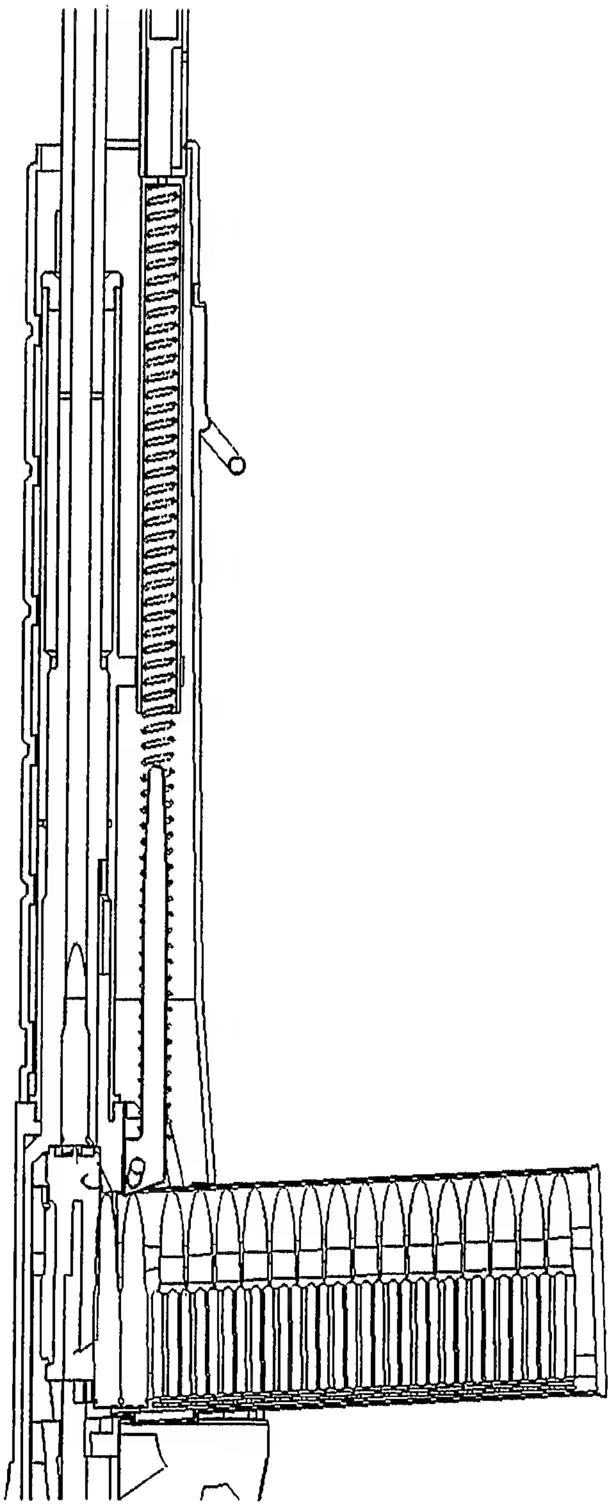
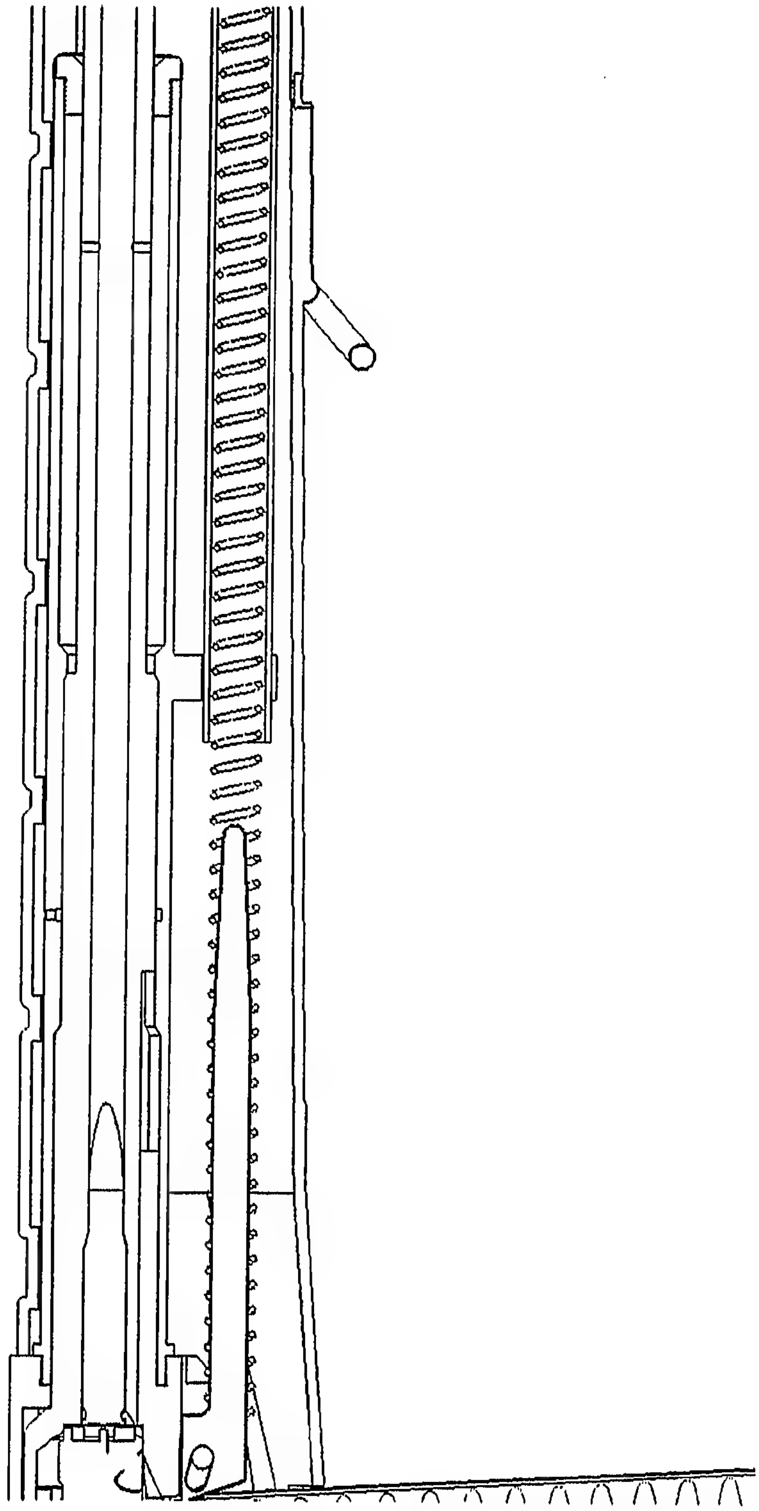


FIG. F3

FIG. F4



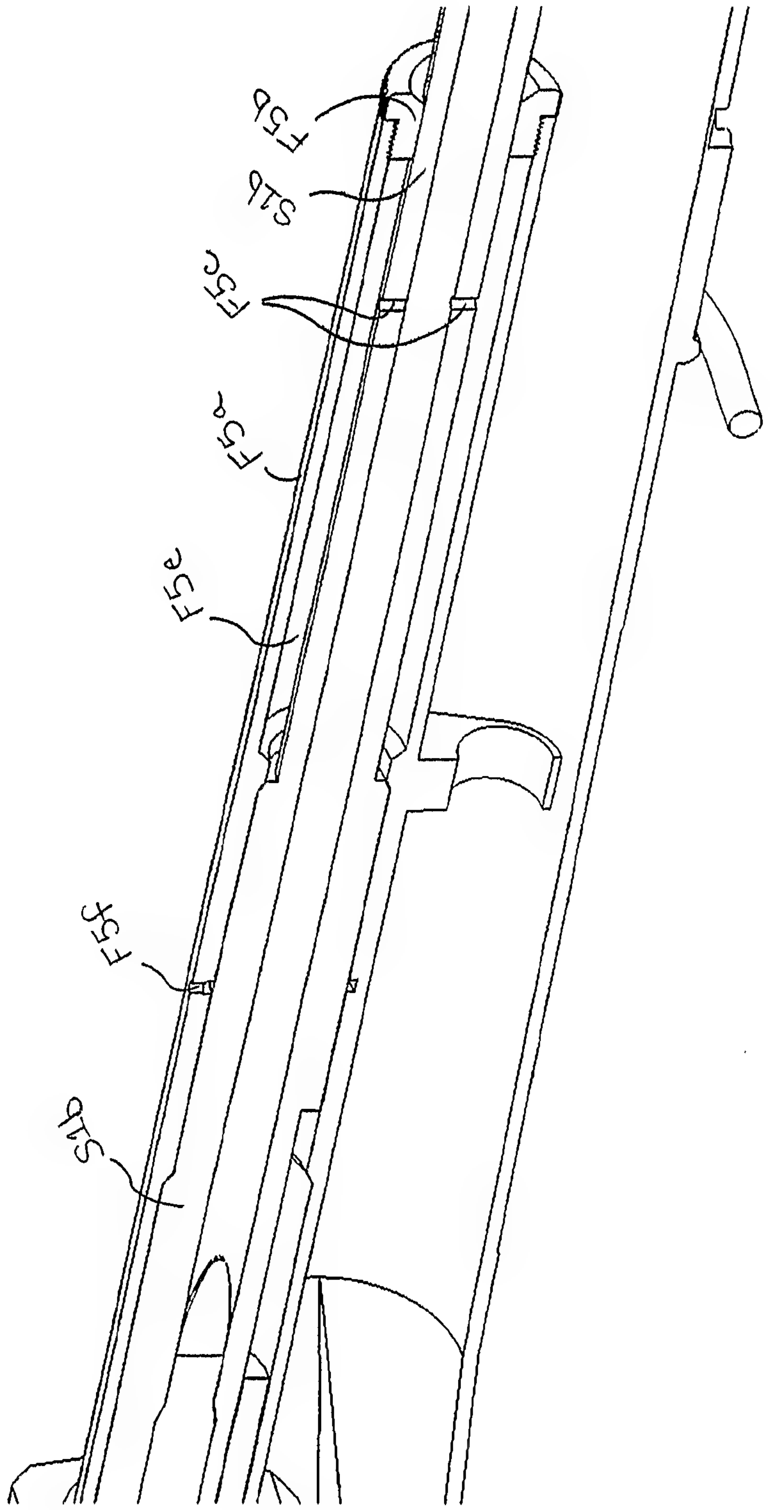


FIG. F5

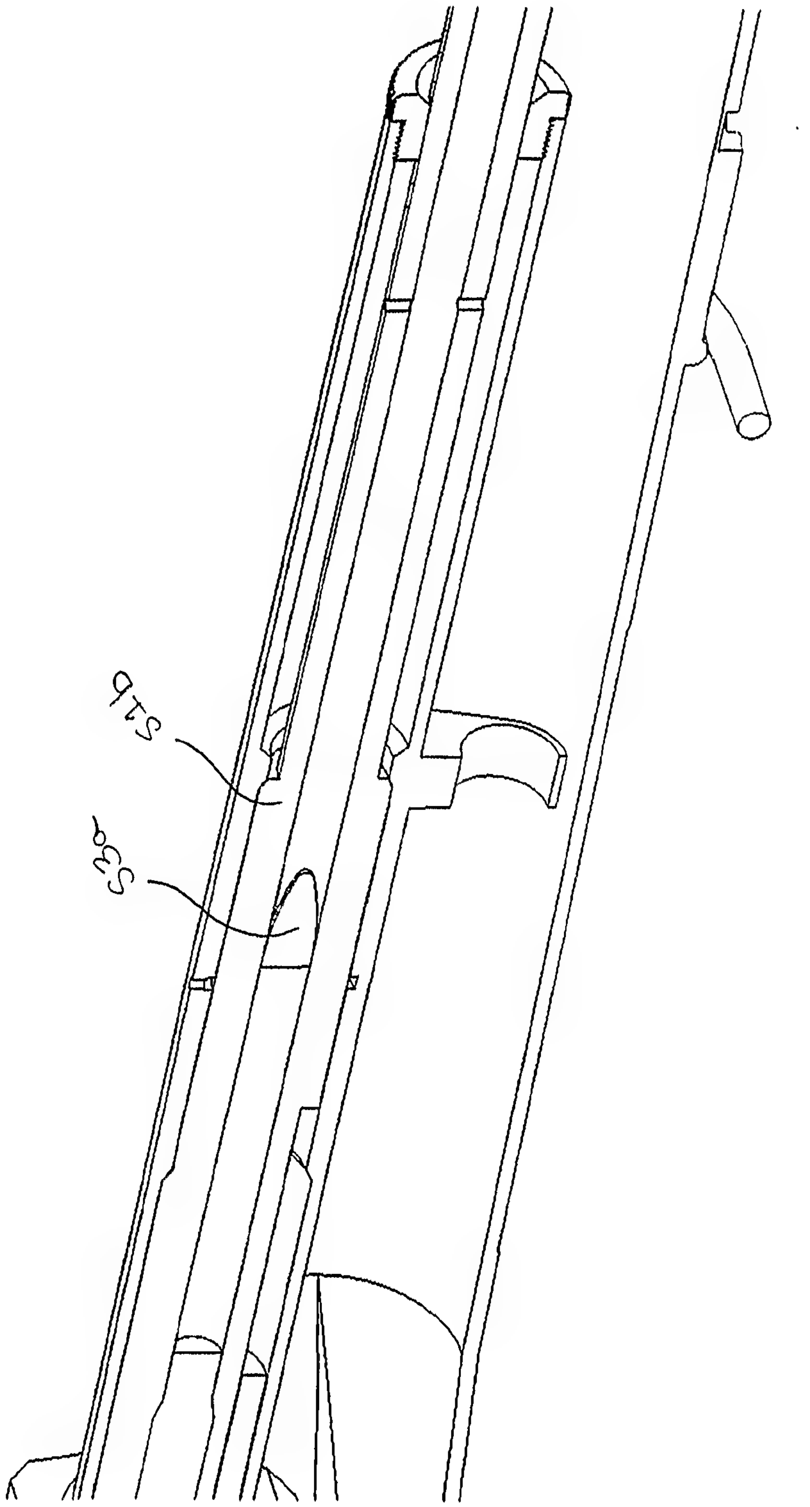


FIG. F6

71 / 200

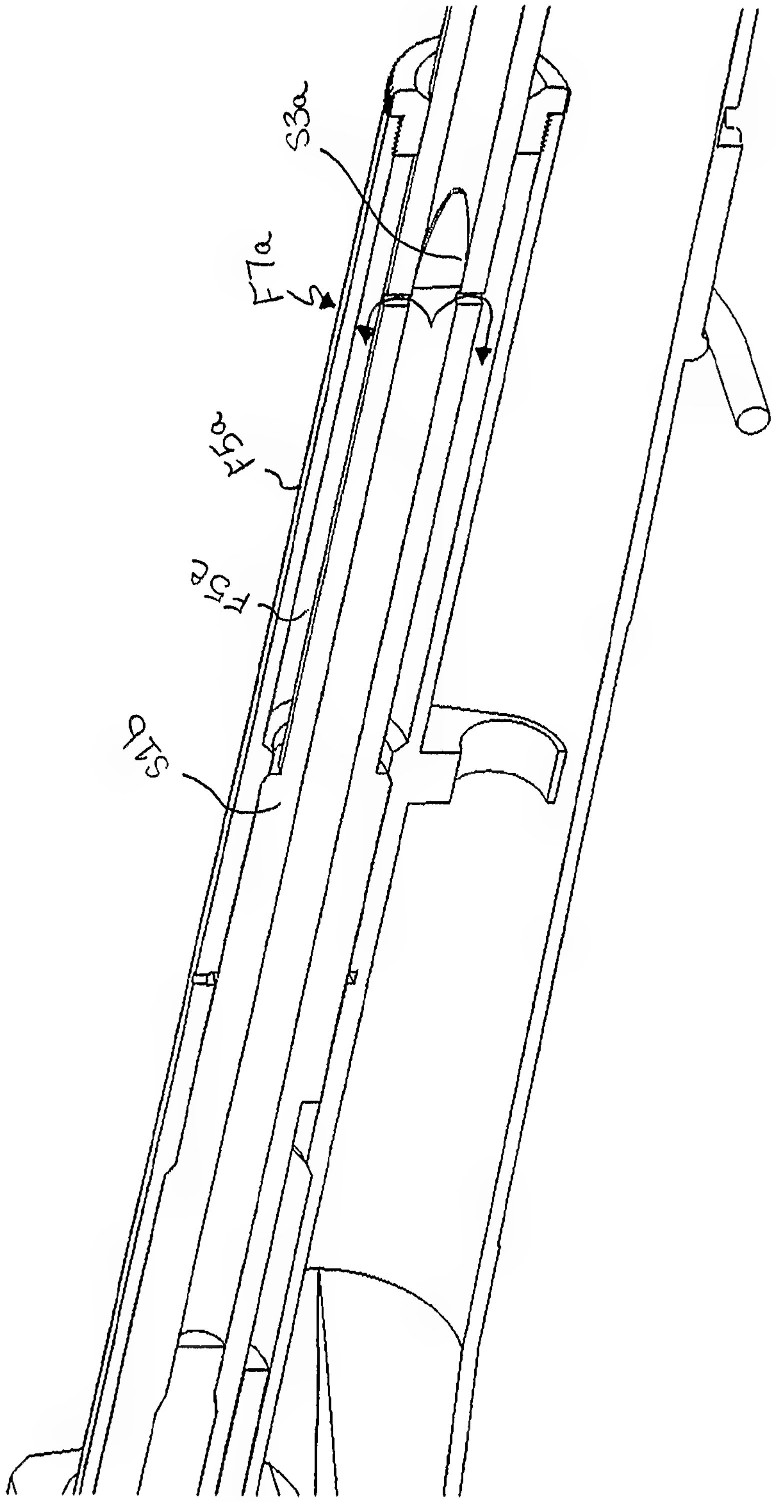


FIG. F7

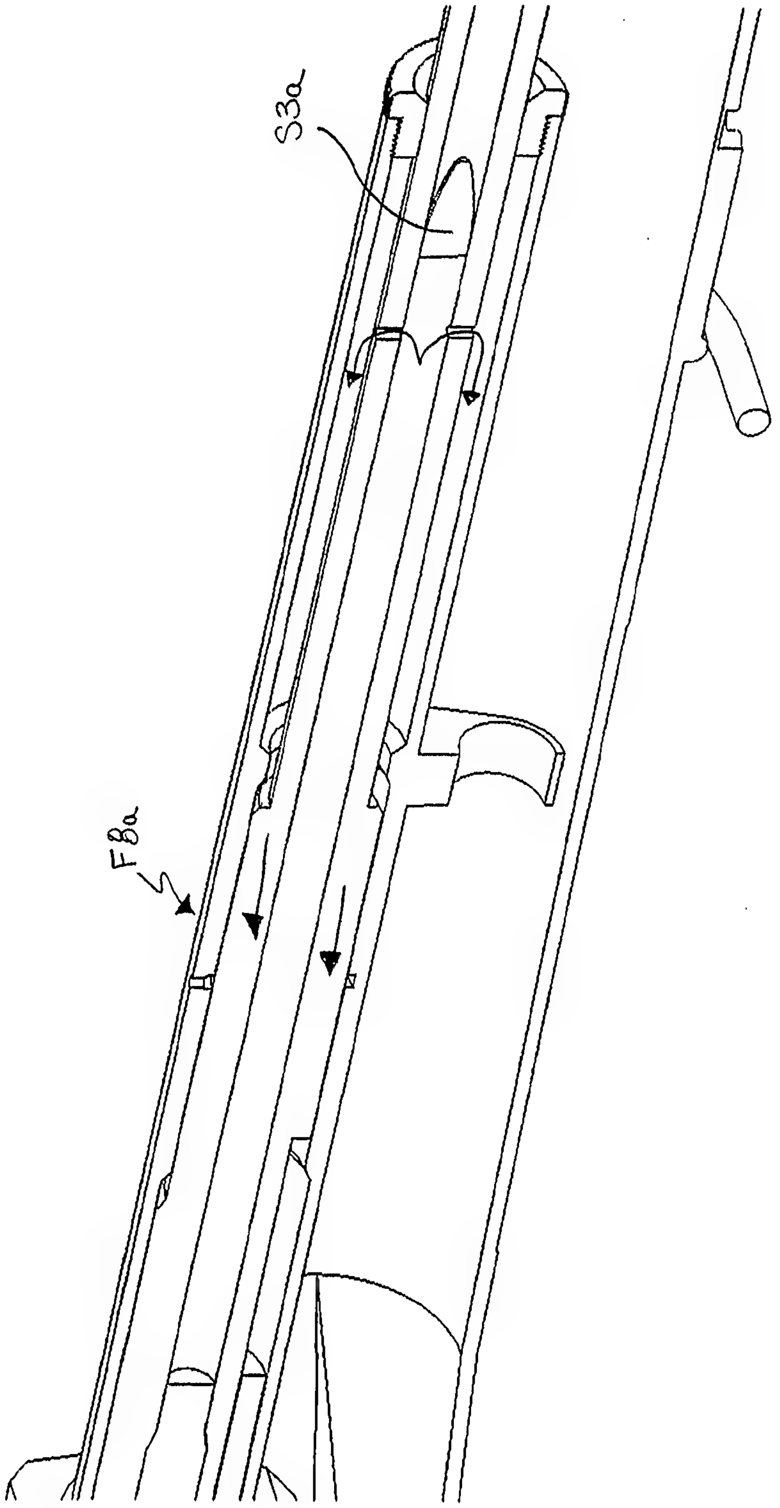


FIG. F8

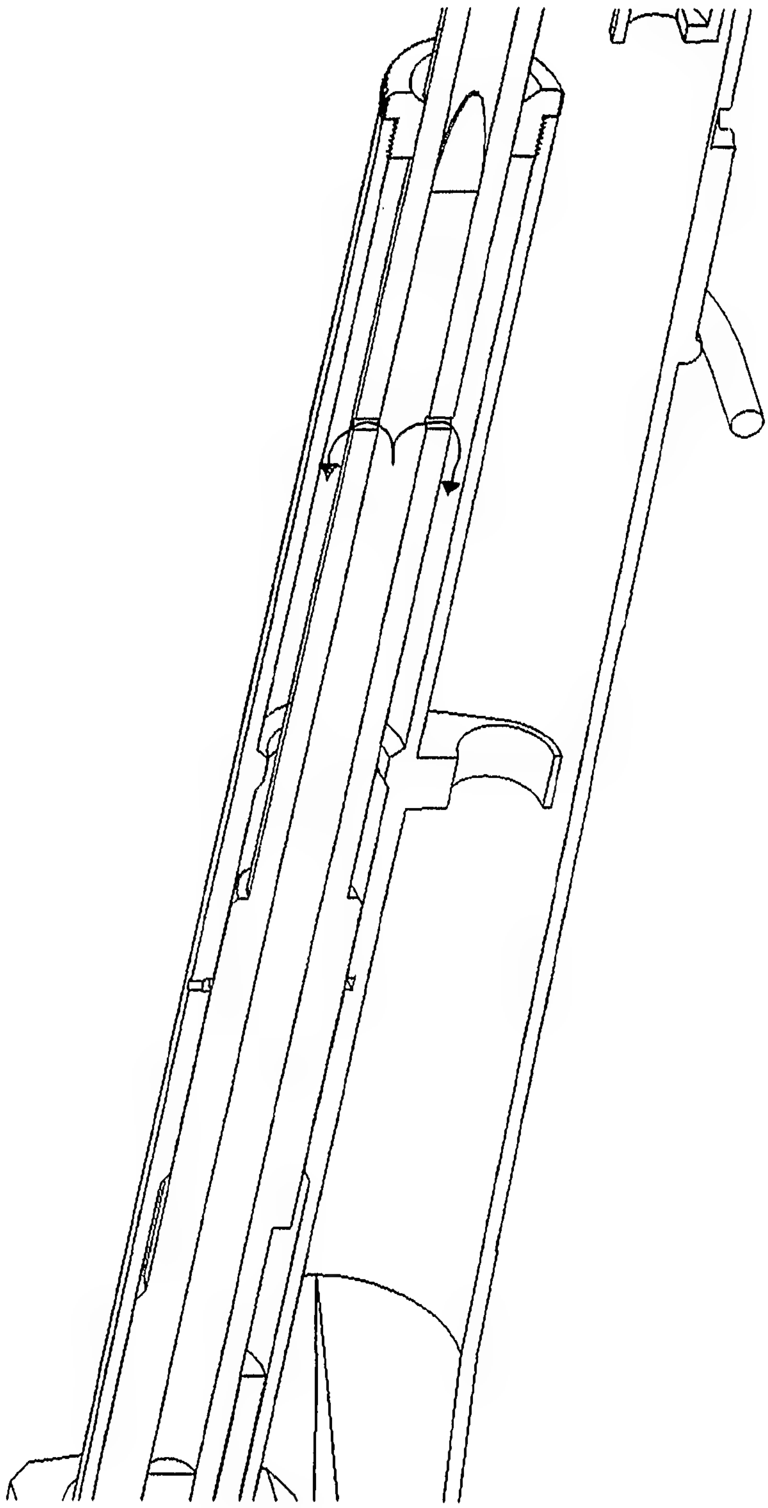
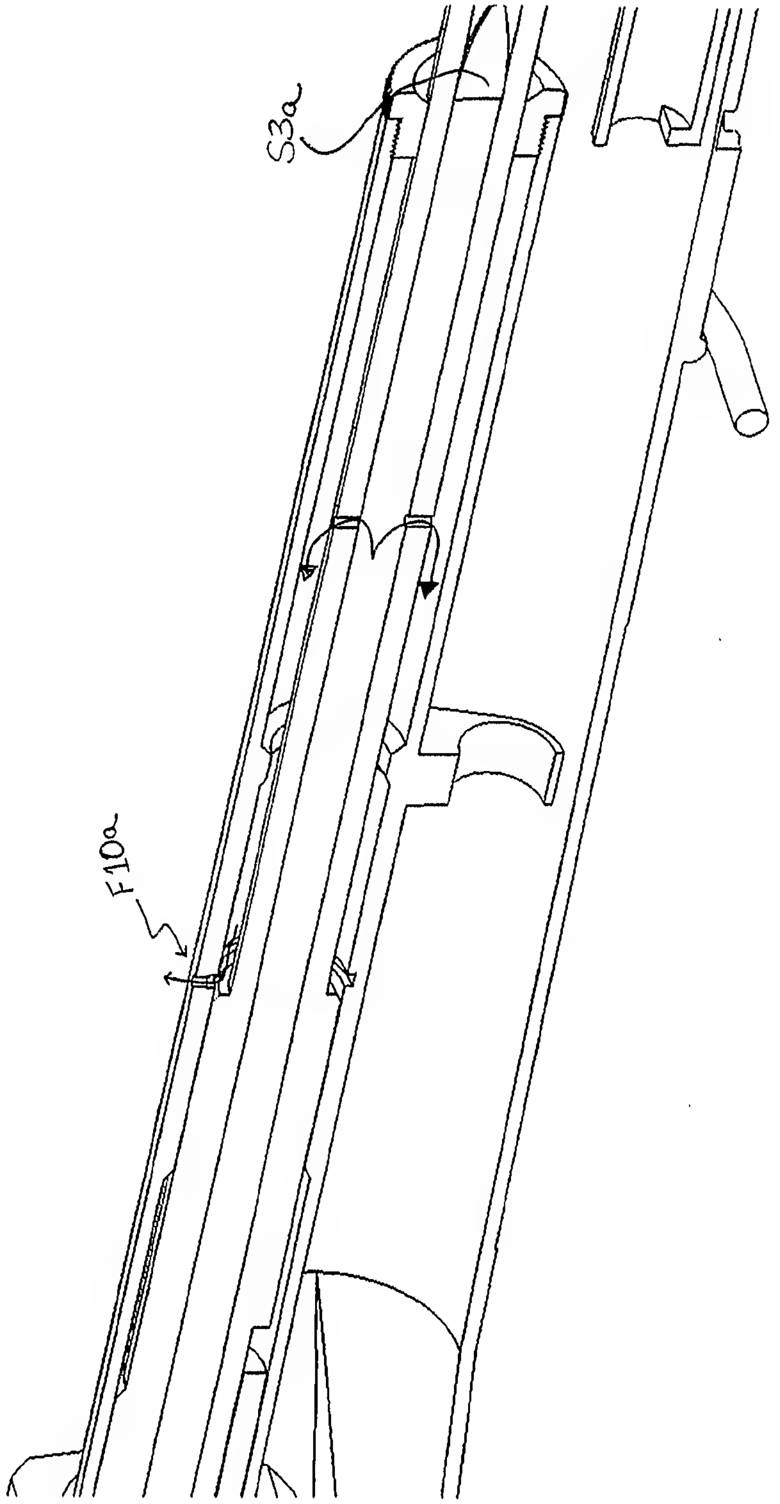


FIG. F9

FIG. F10



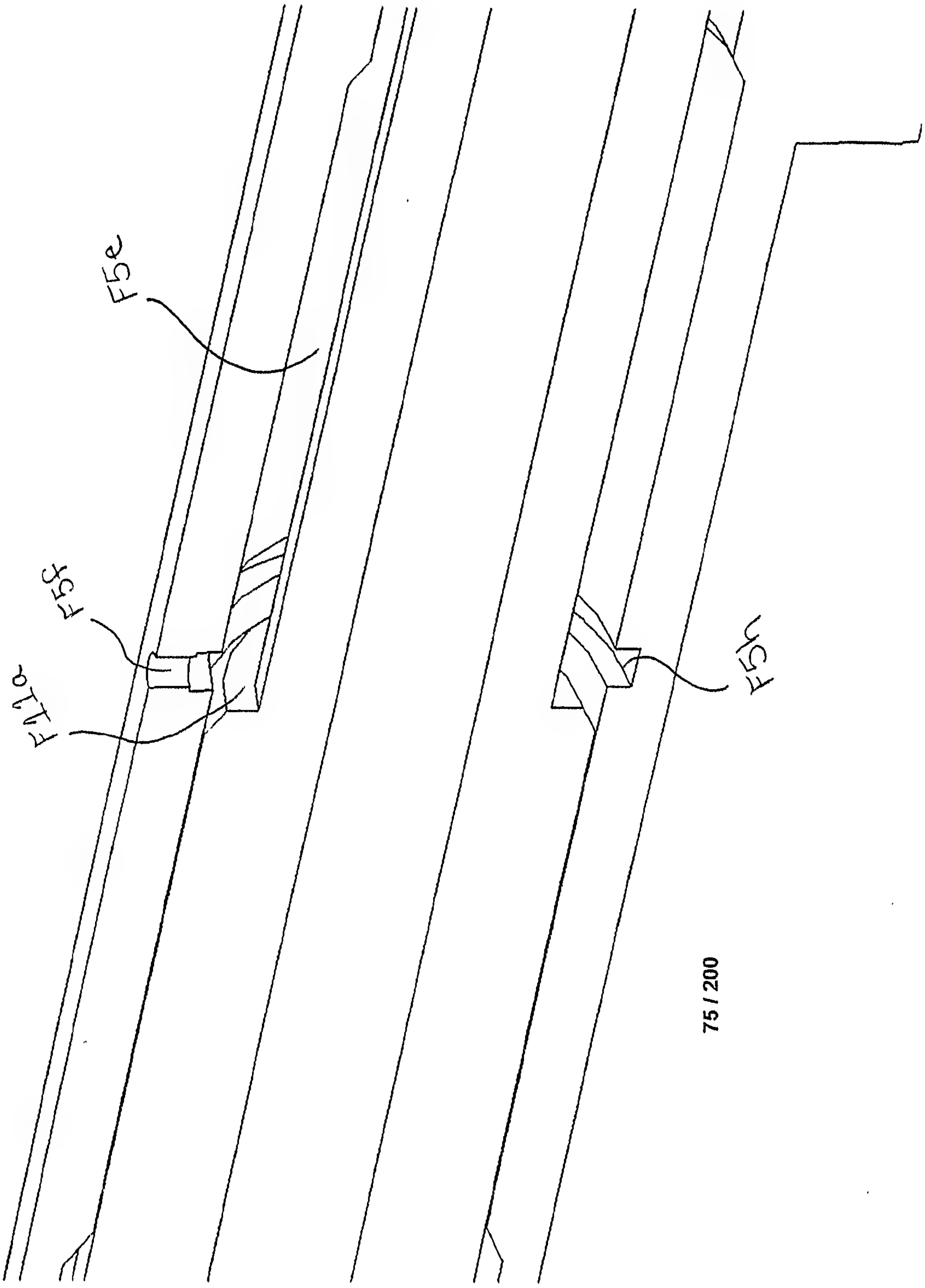
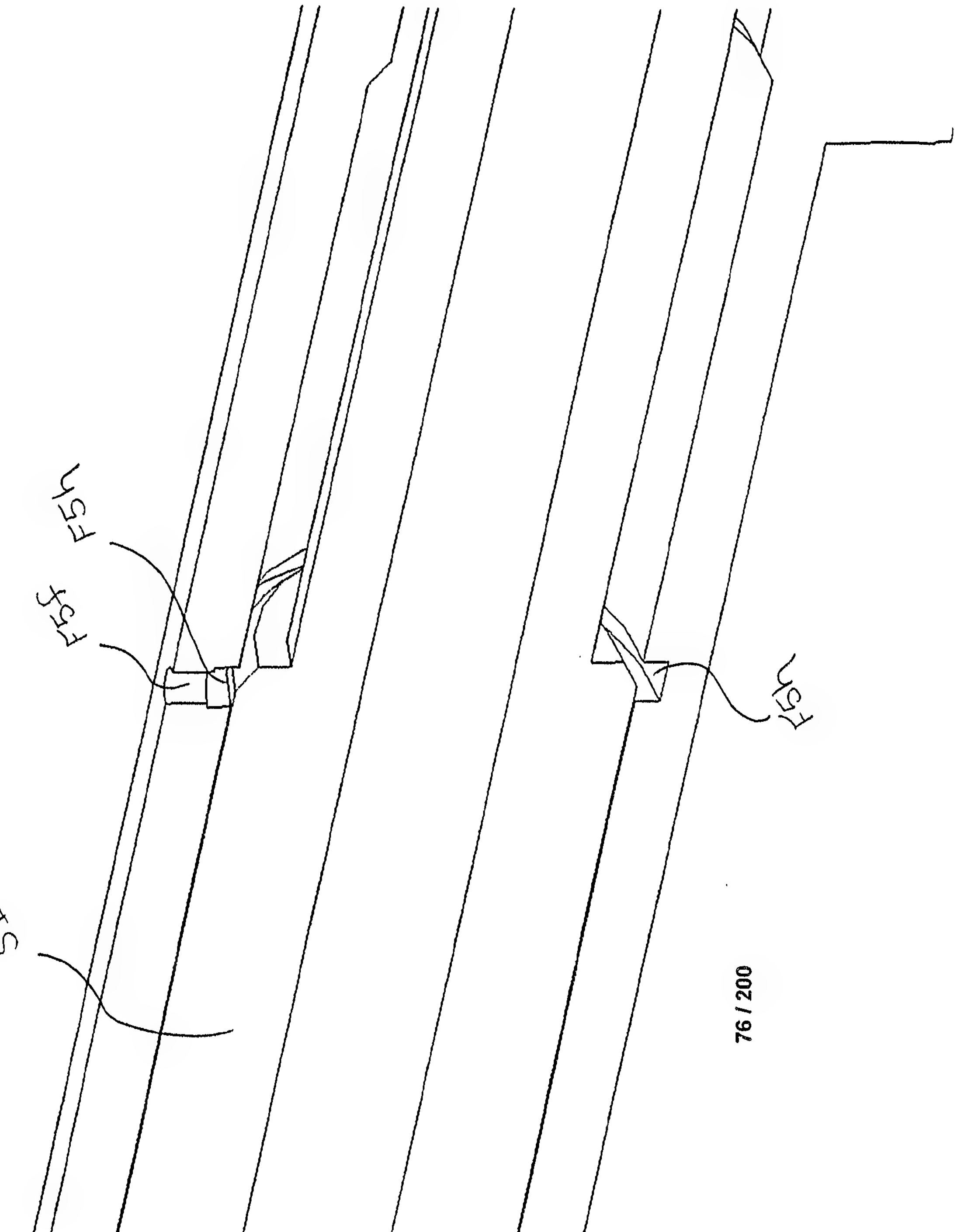


FIG. F11

FIG. F12



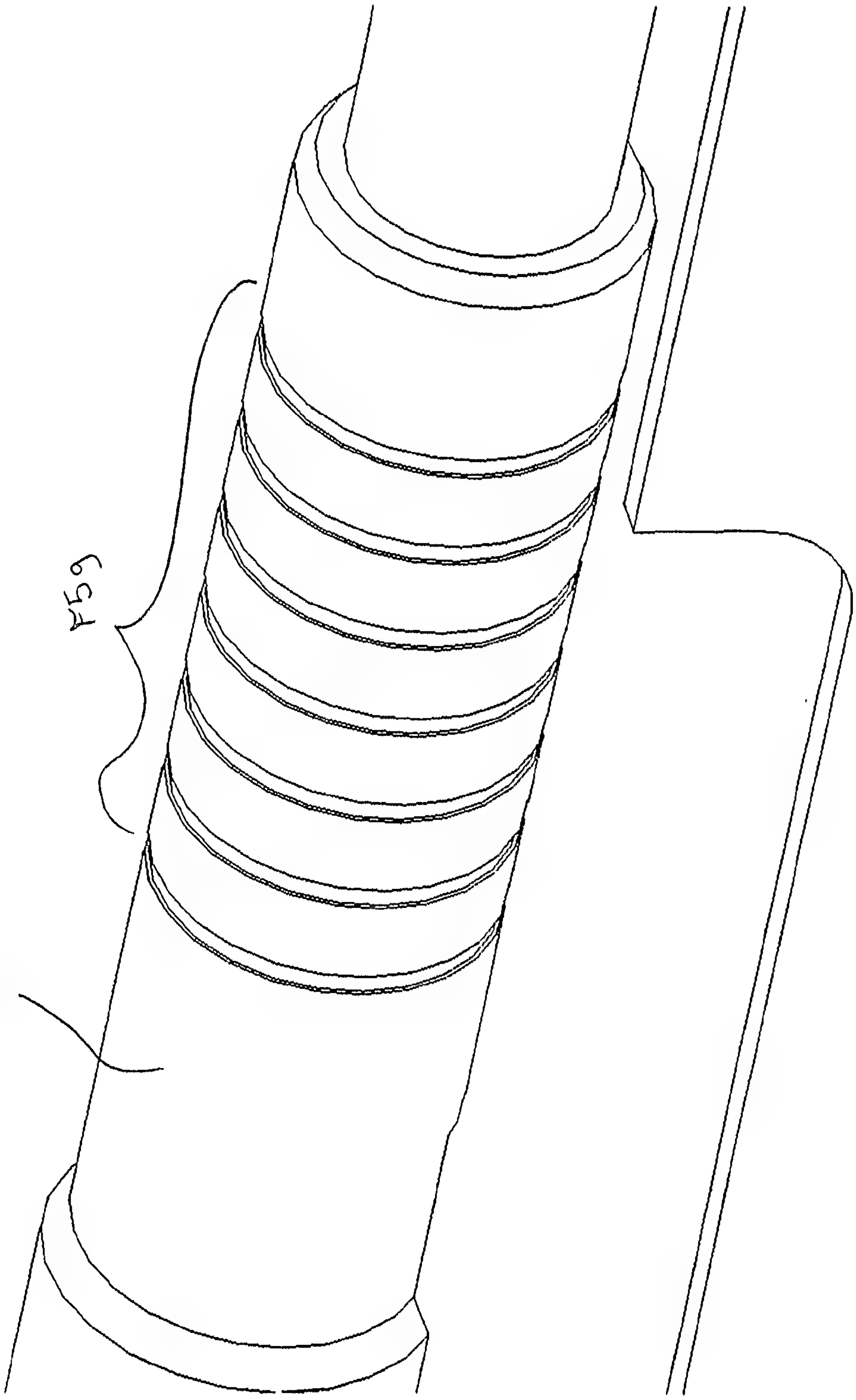
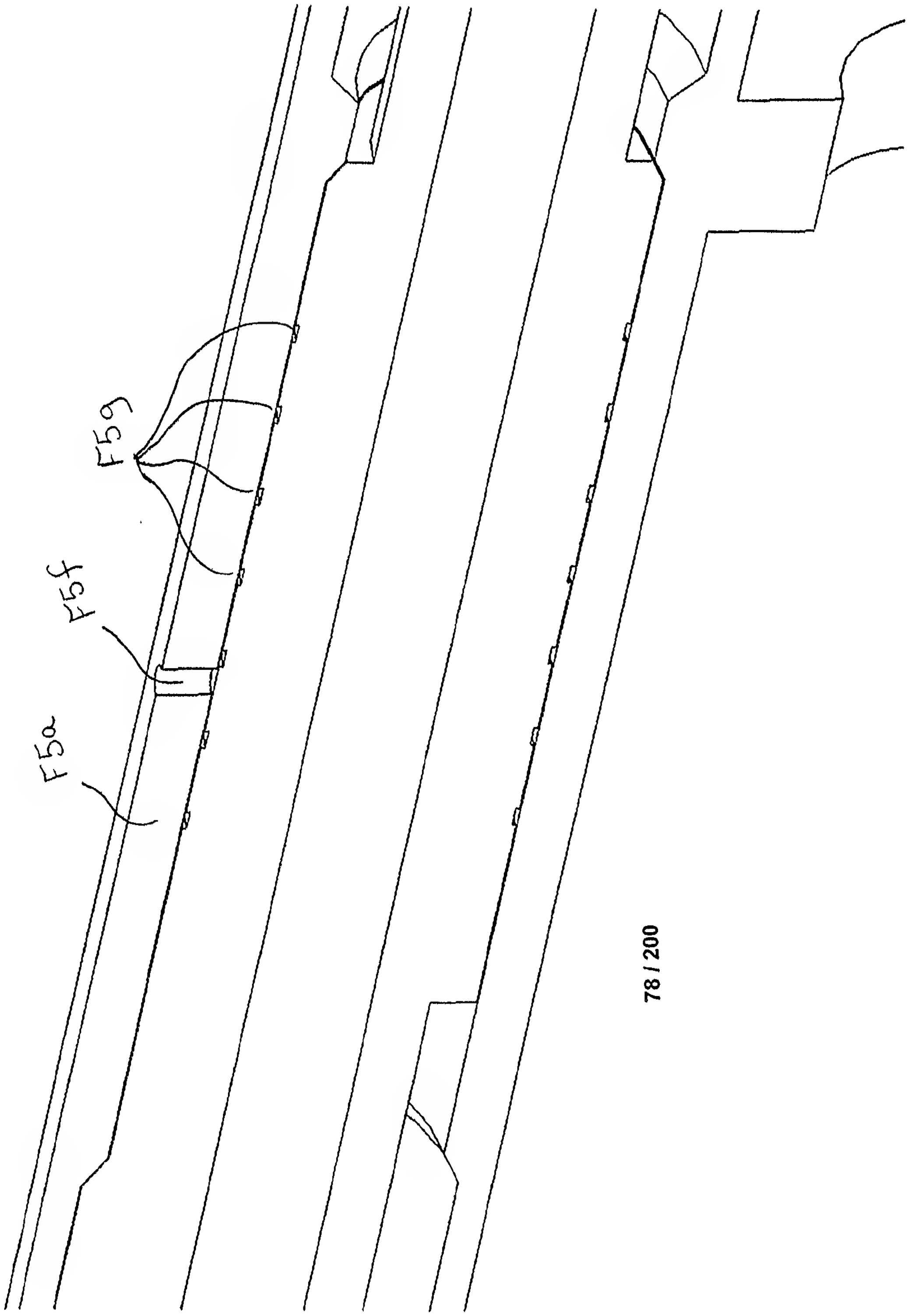


FIG. F13

FIG. F14



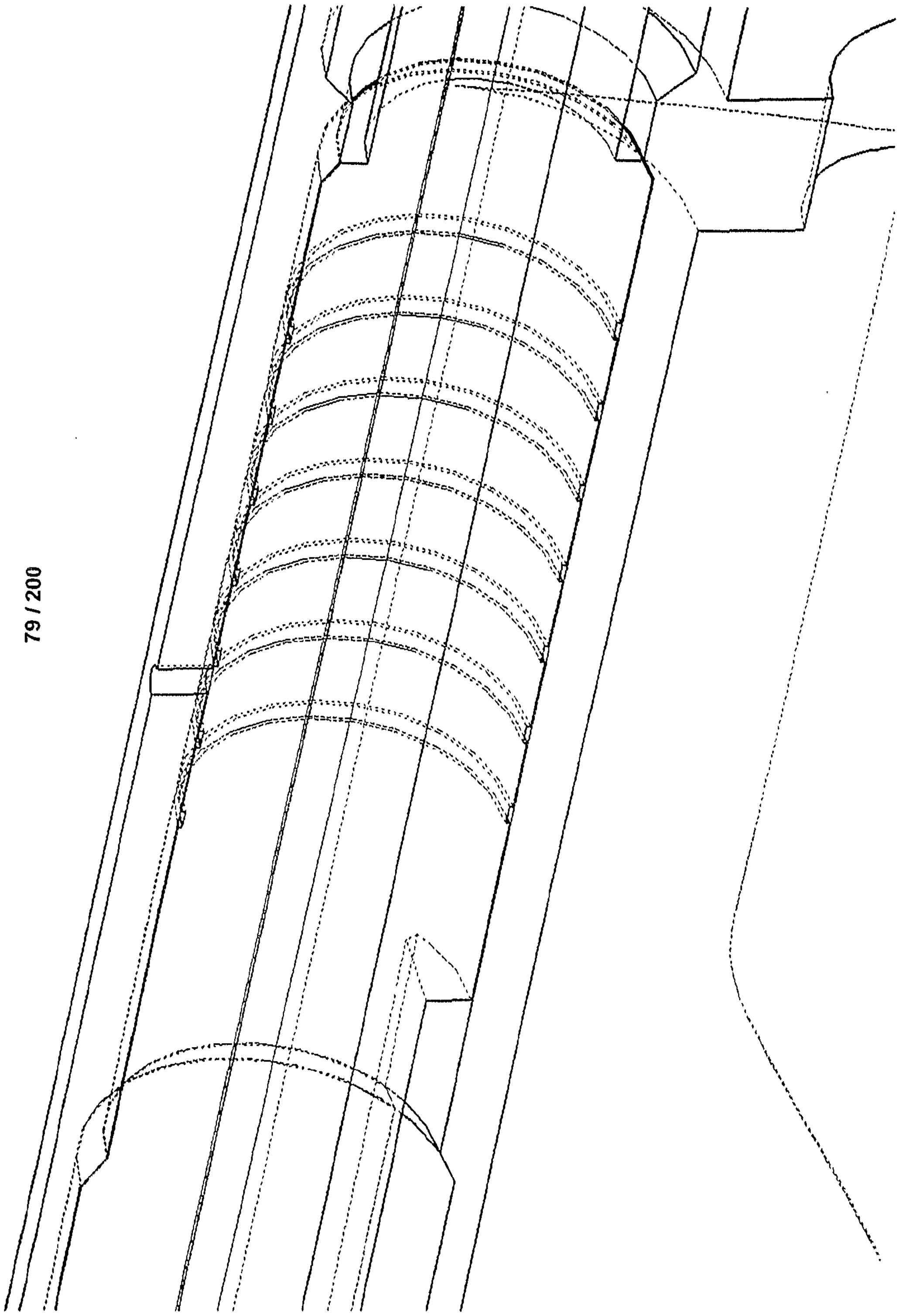


FIG. F15

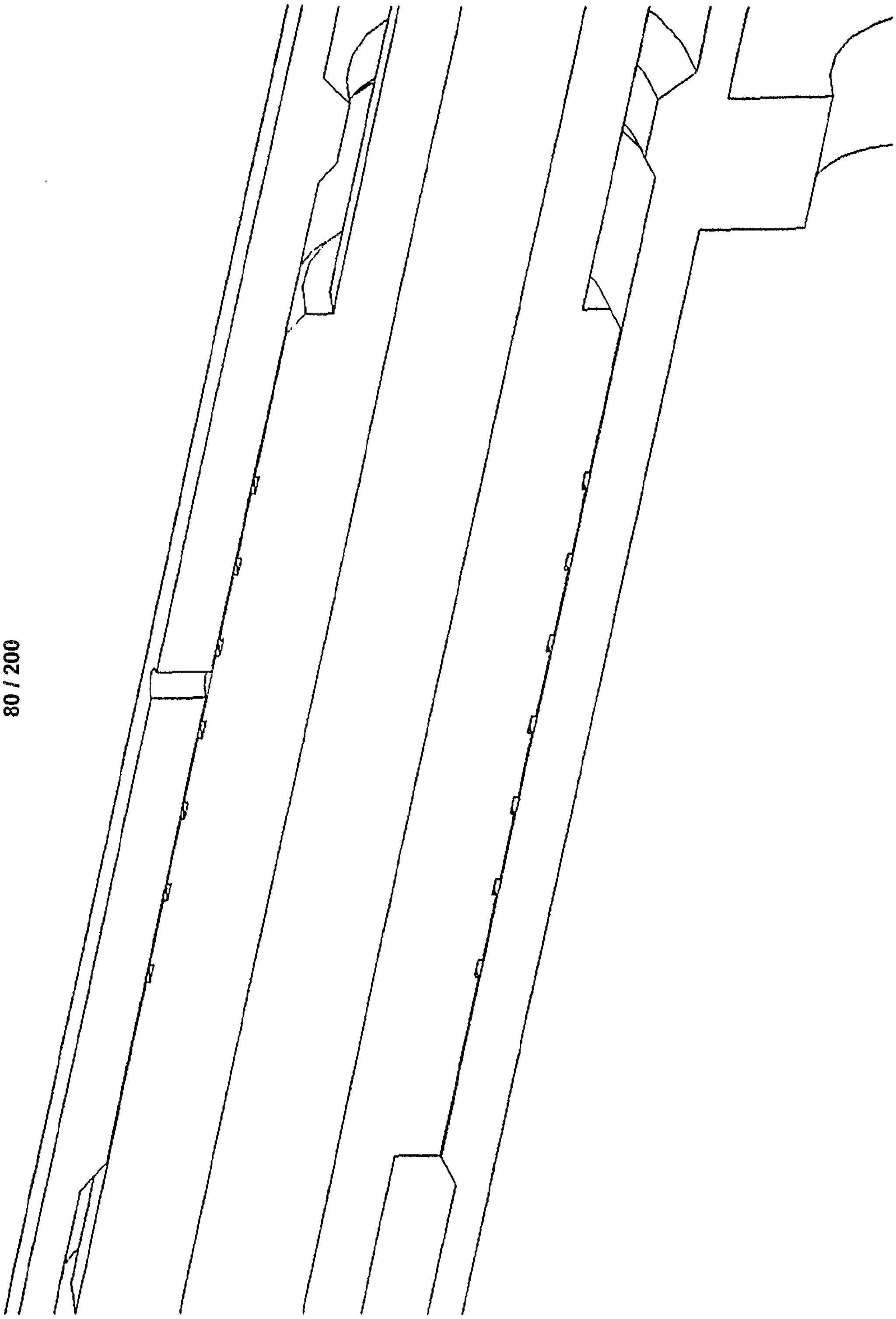


FIG. F16

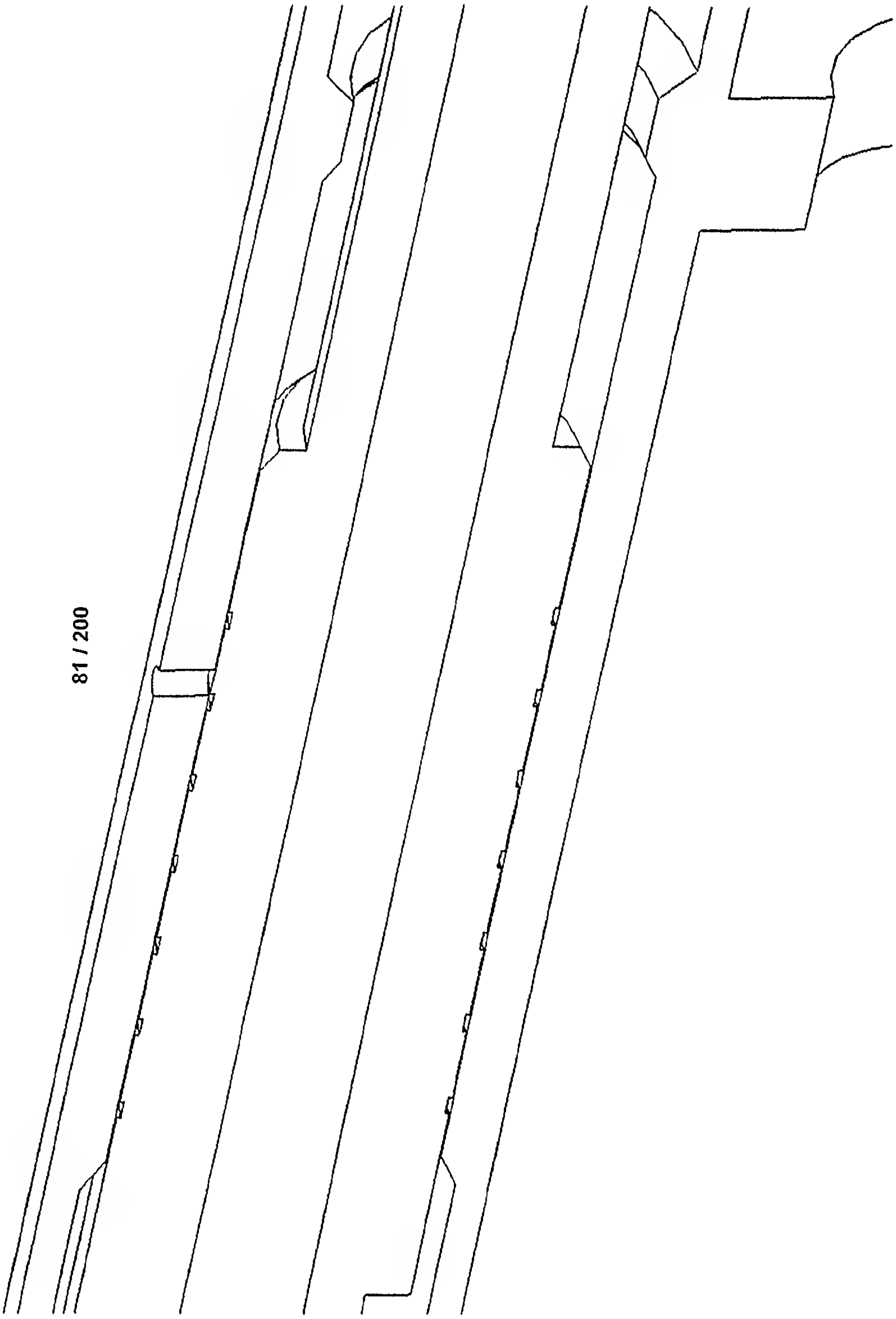


FIG. F17

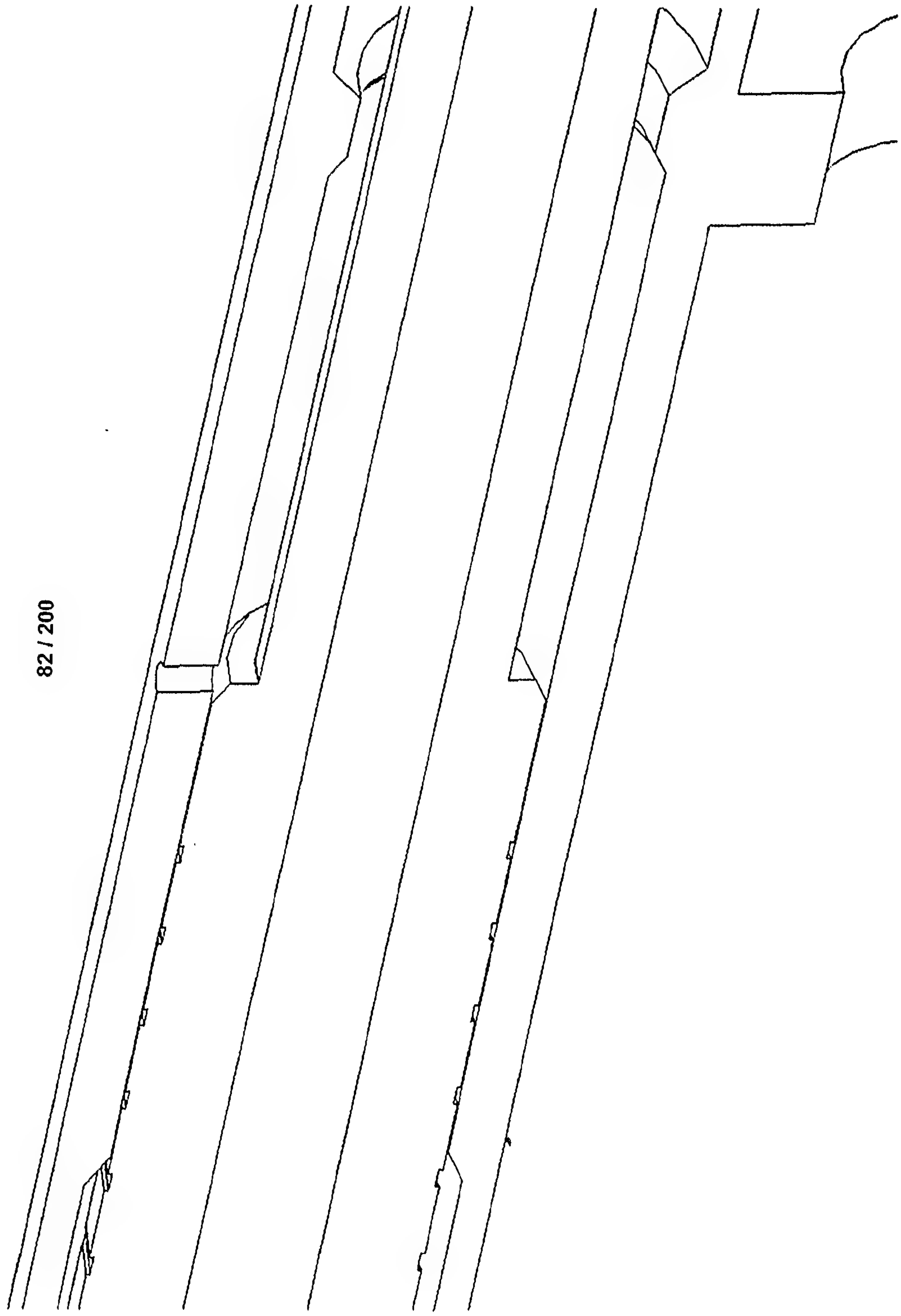


FIG. F18

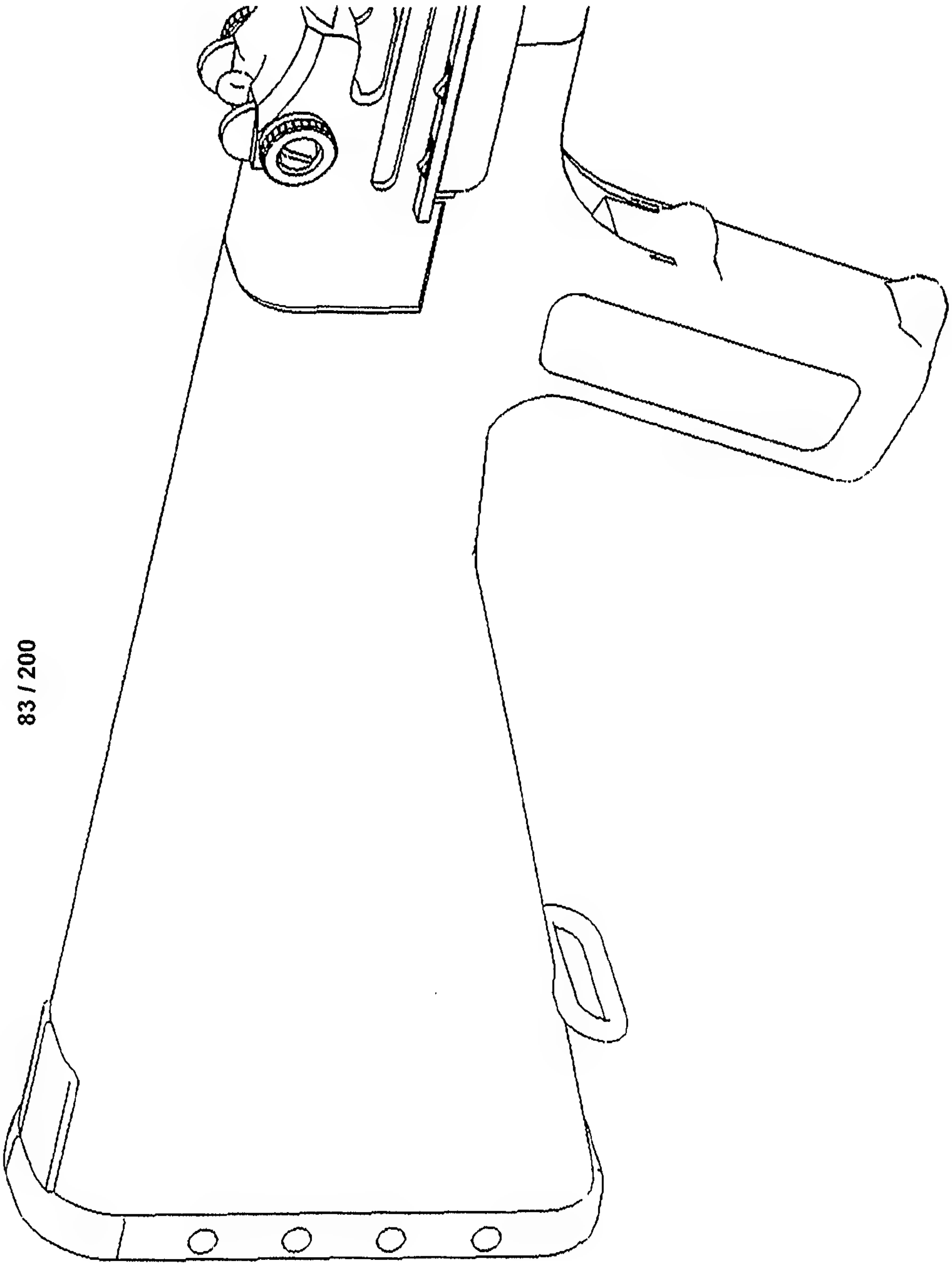


FIG. G1

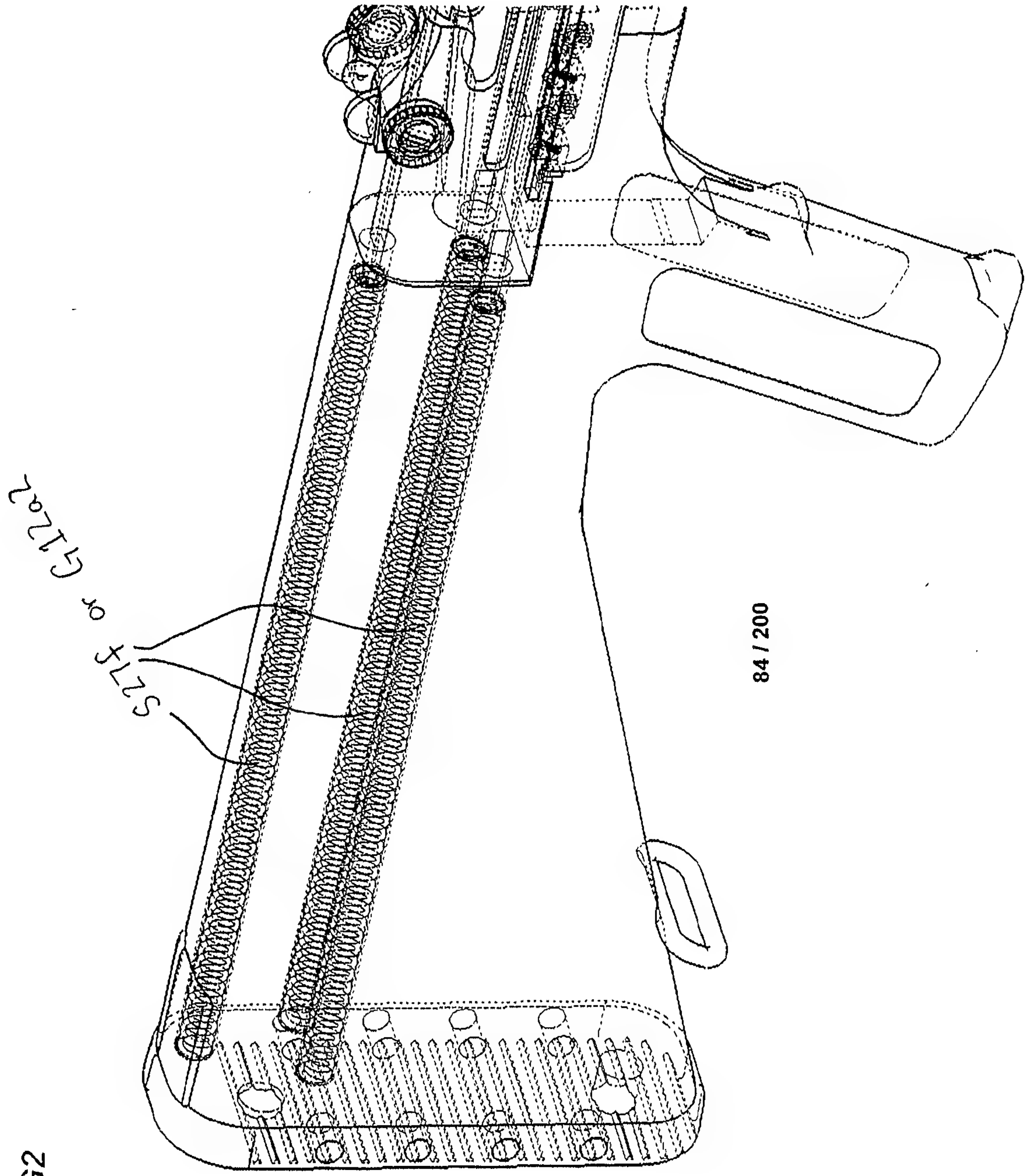
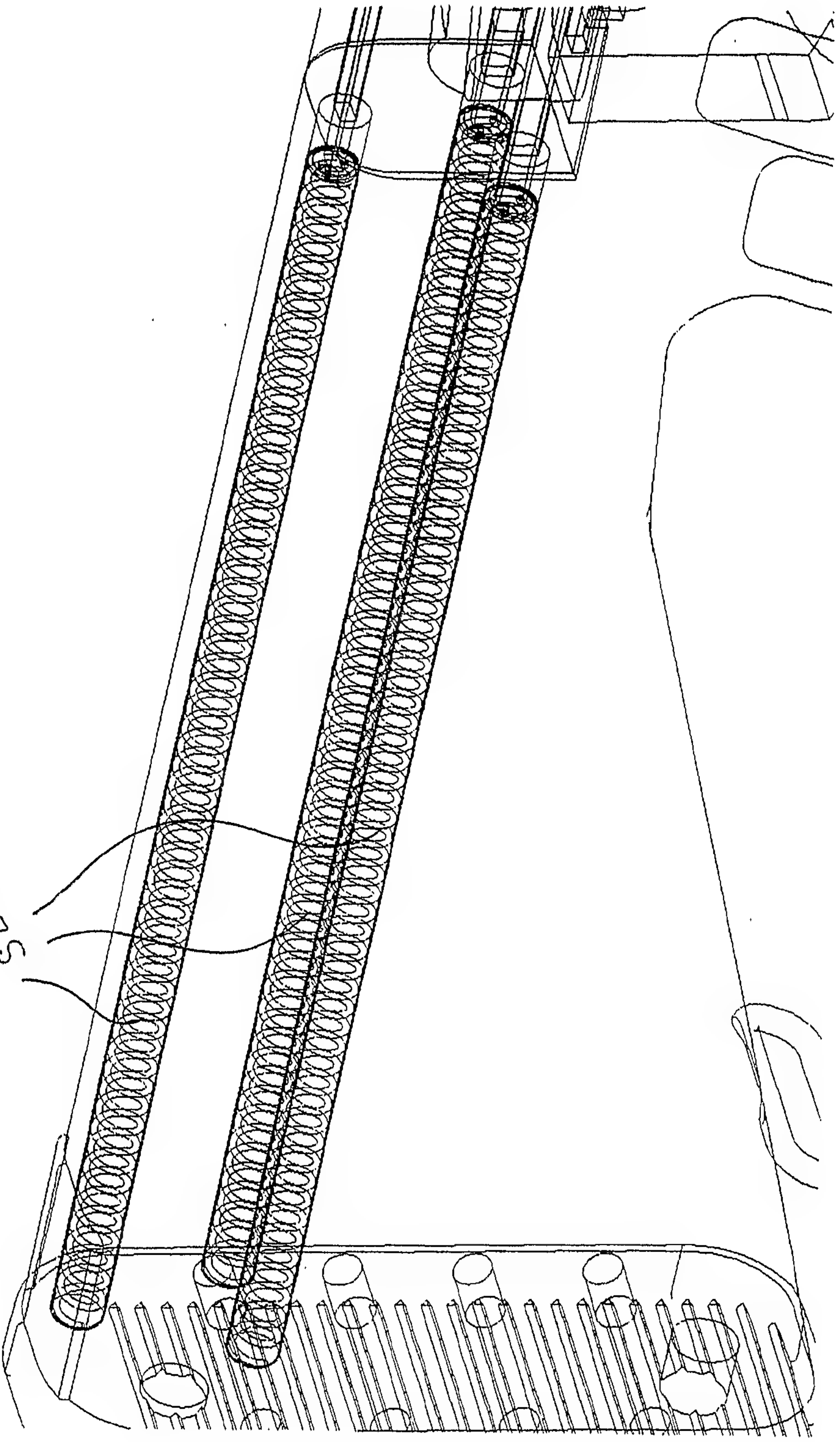


FIG. G2

FIG. G3

527f or 612a



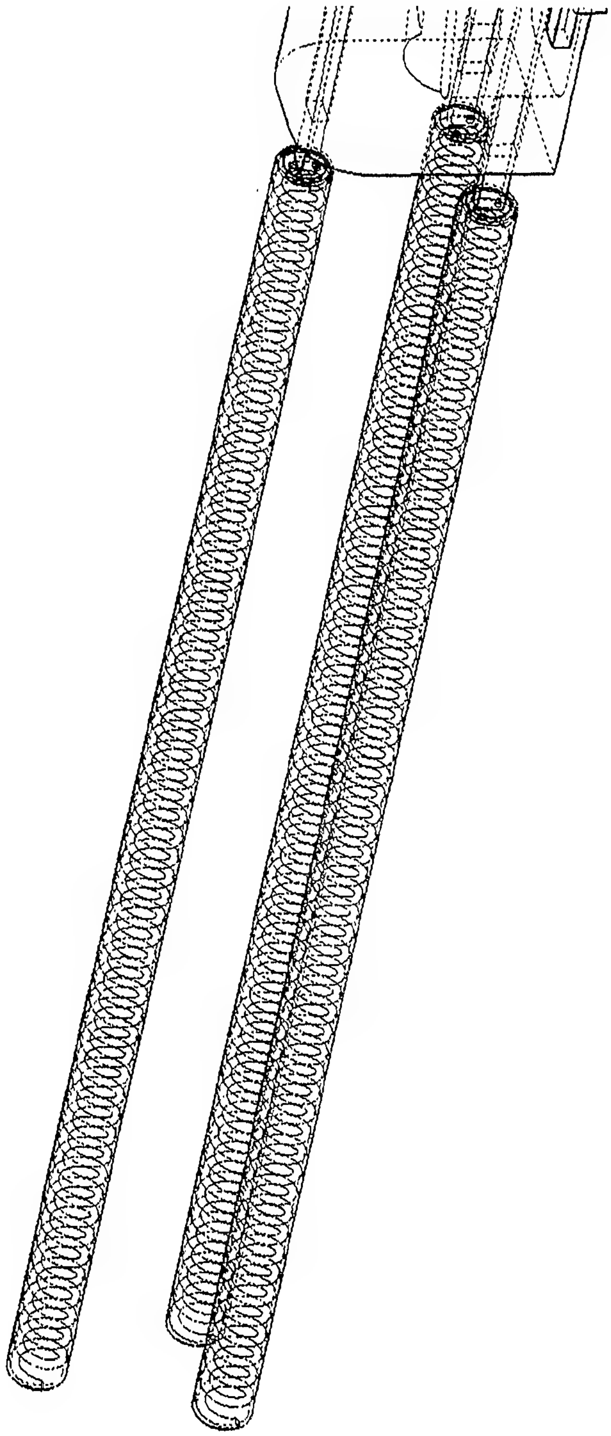


FIG. G4

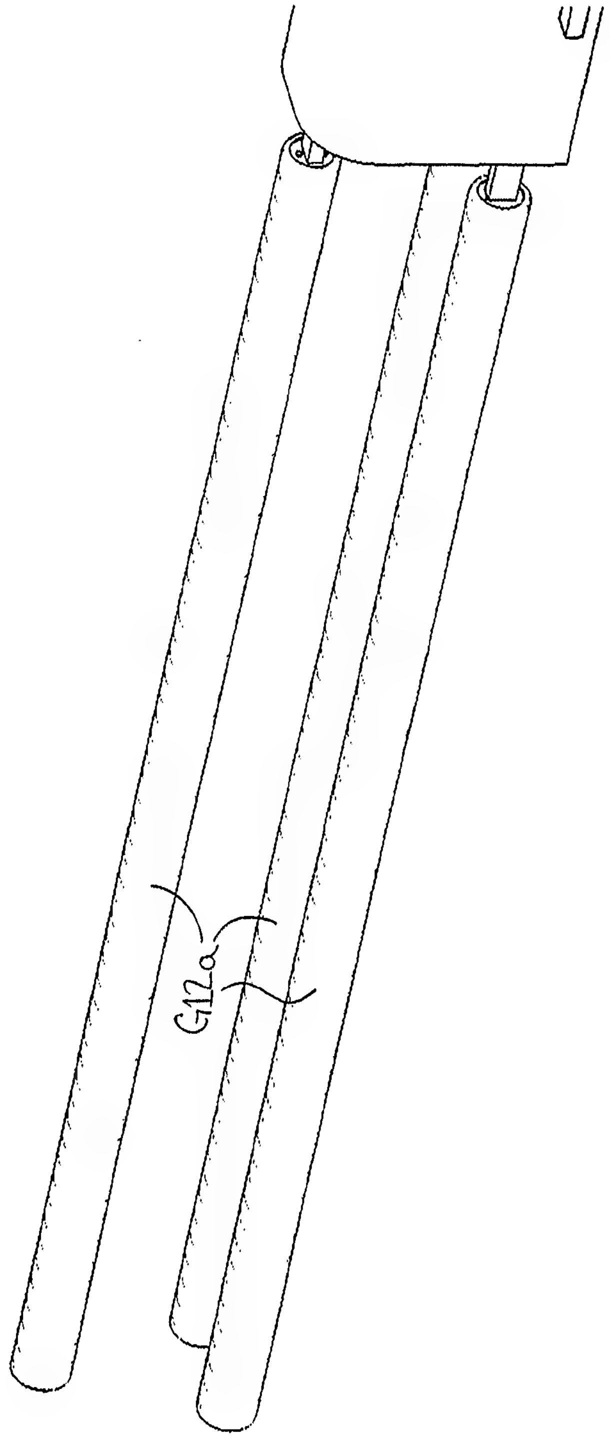
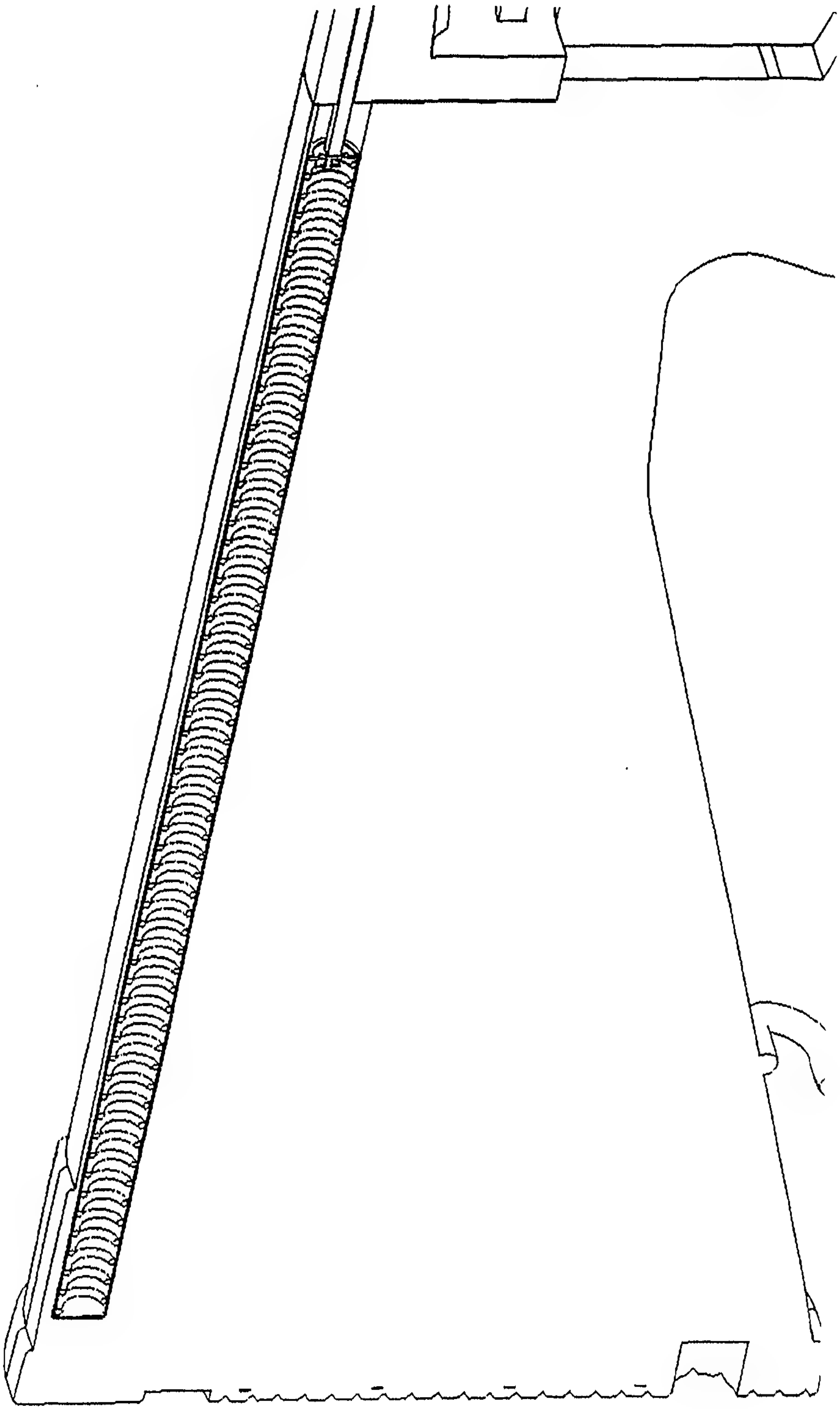


FIG. G5

FIG. G6



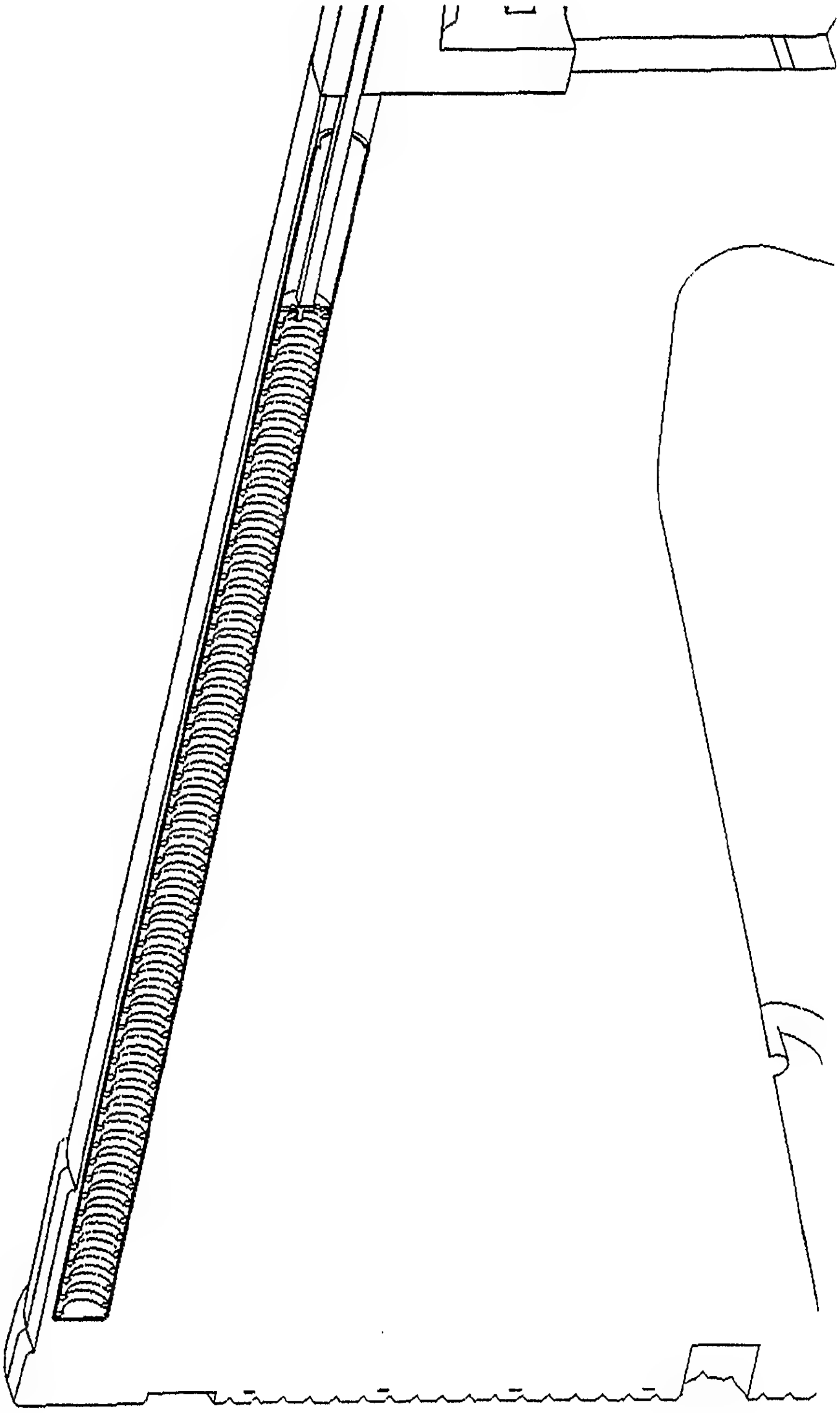


FIG. G7

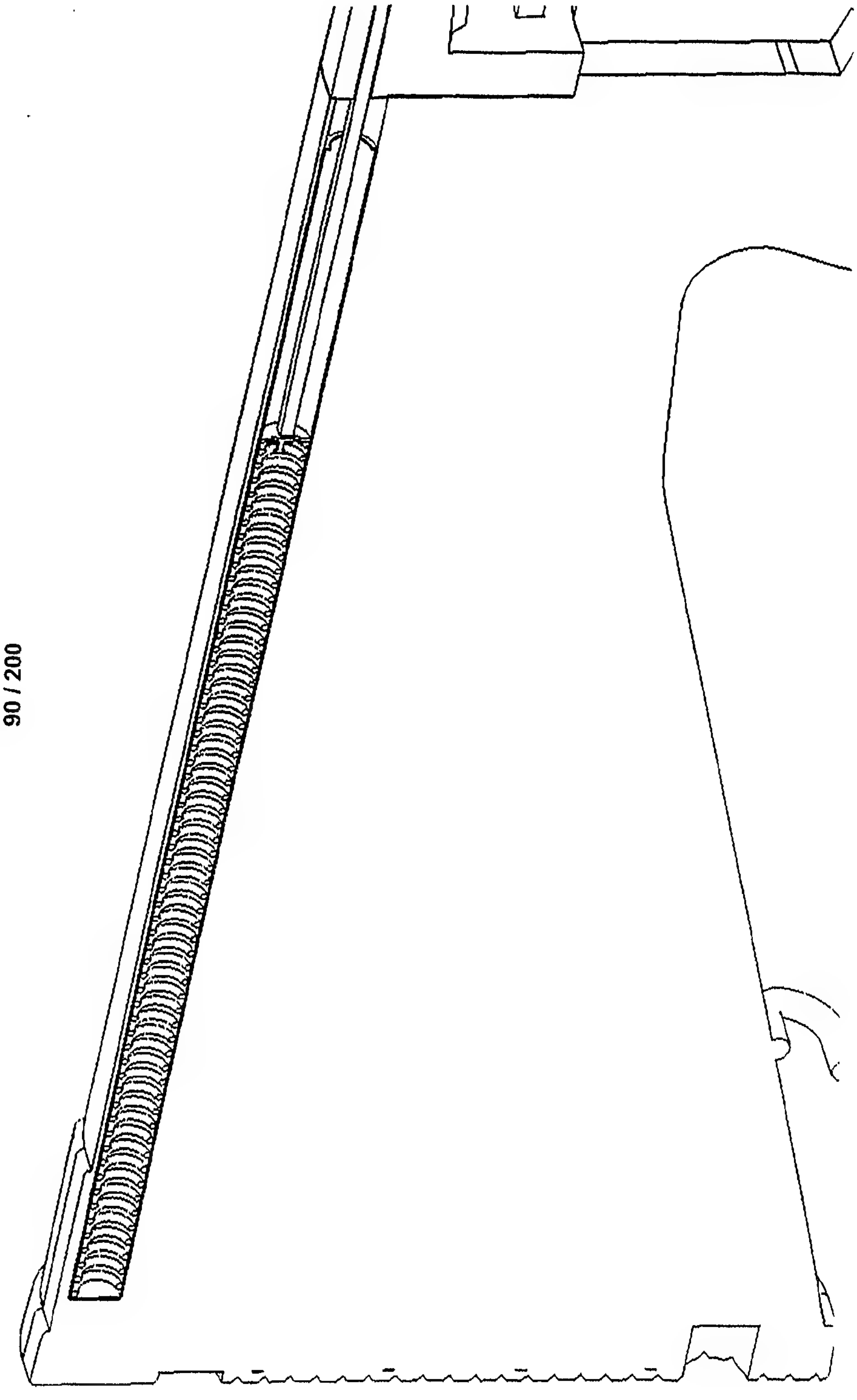


FIG. G8

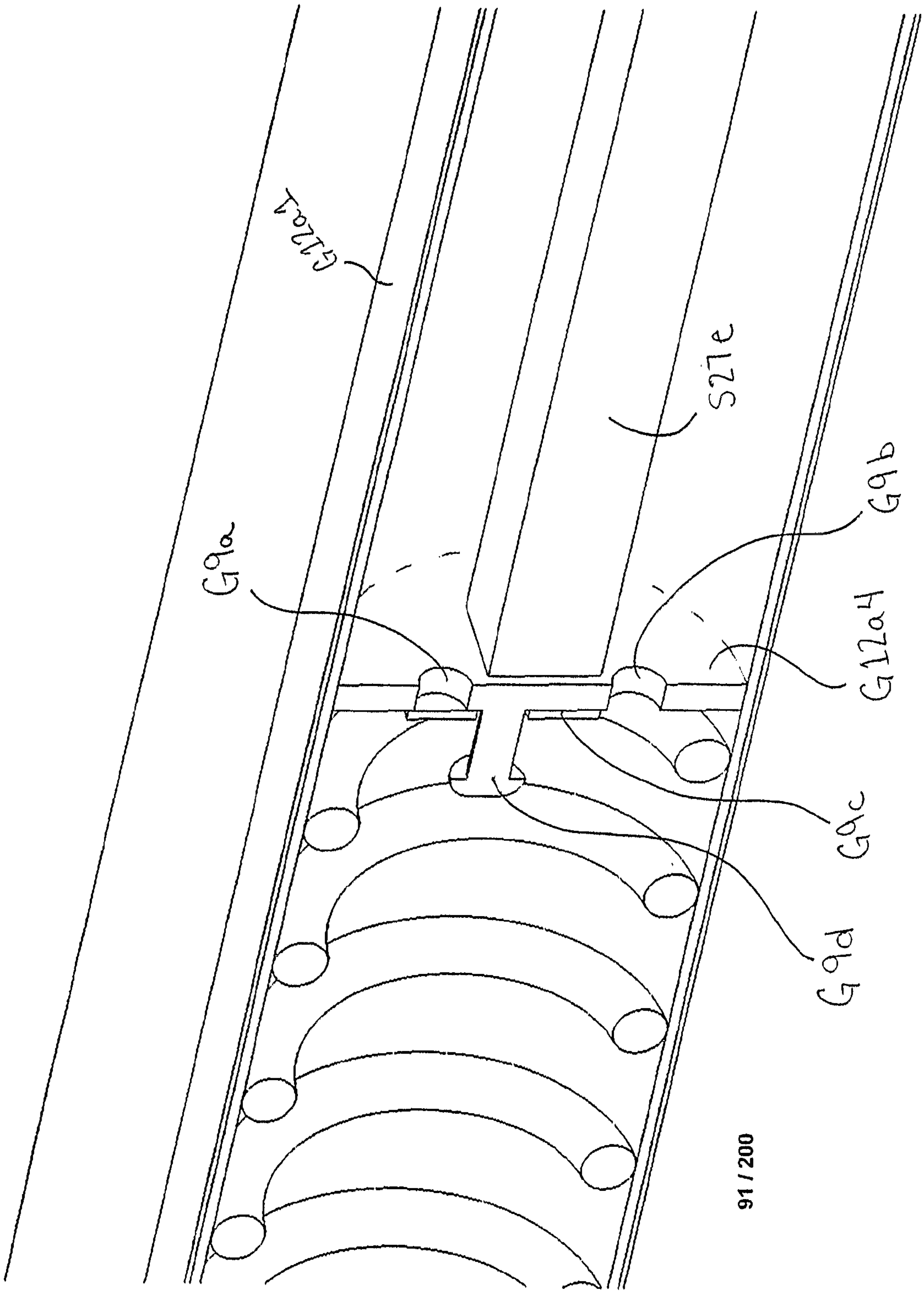
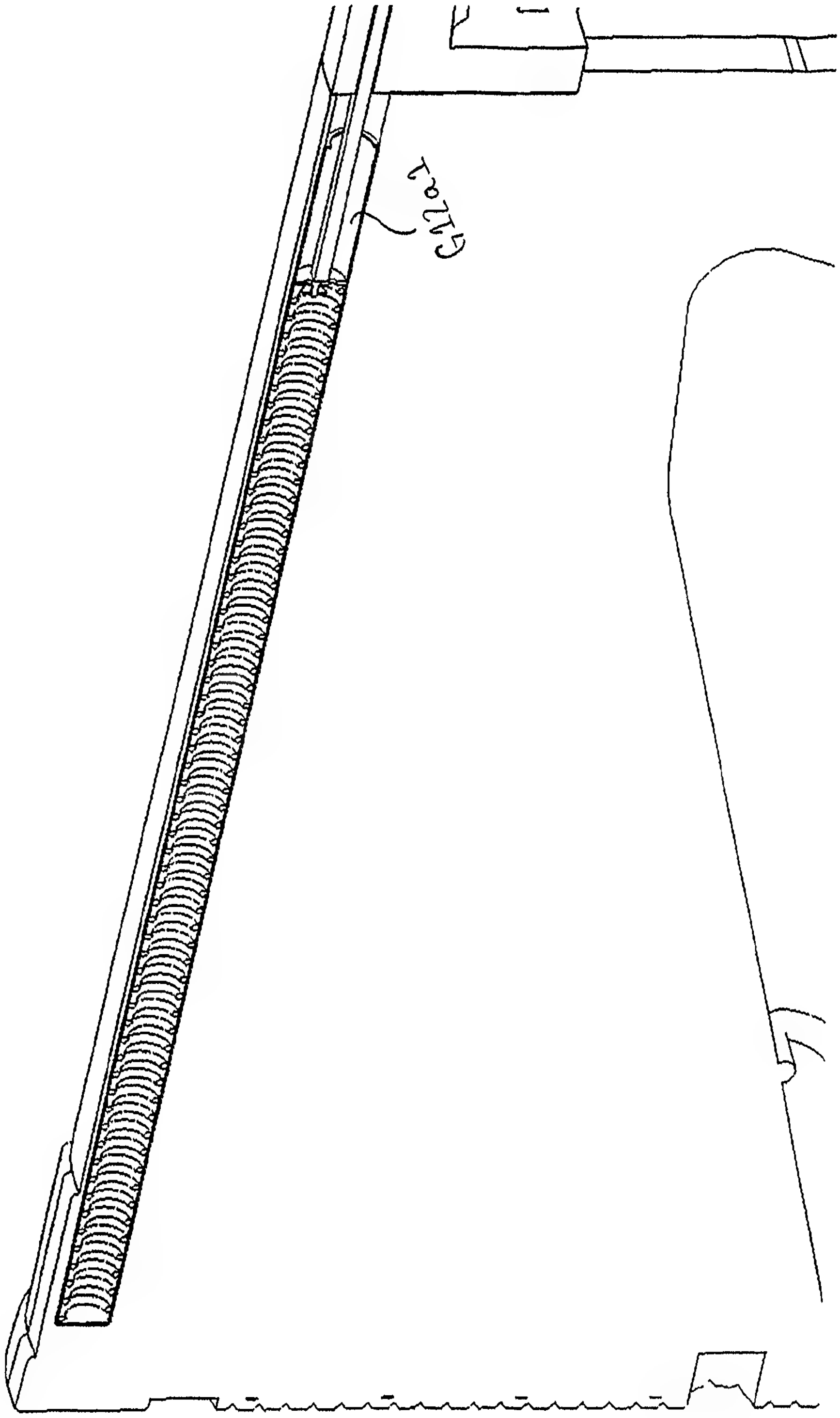


FIG. G9

FIG. G10



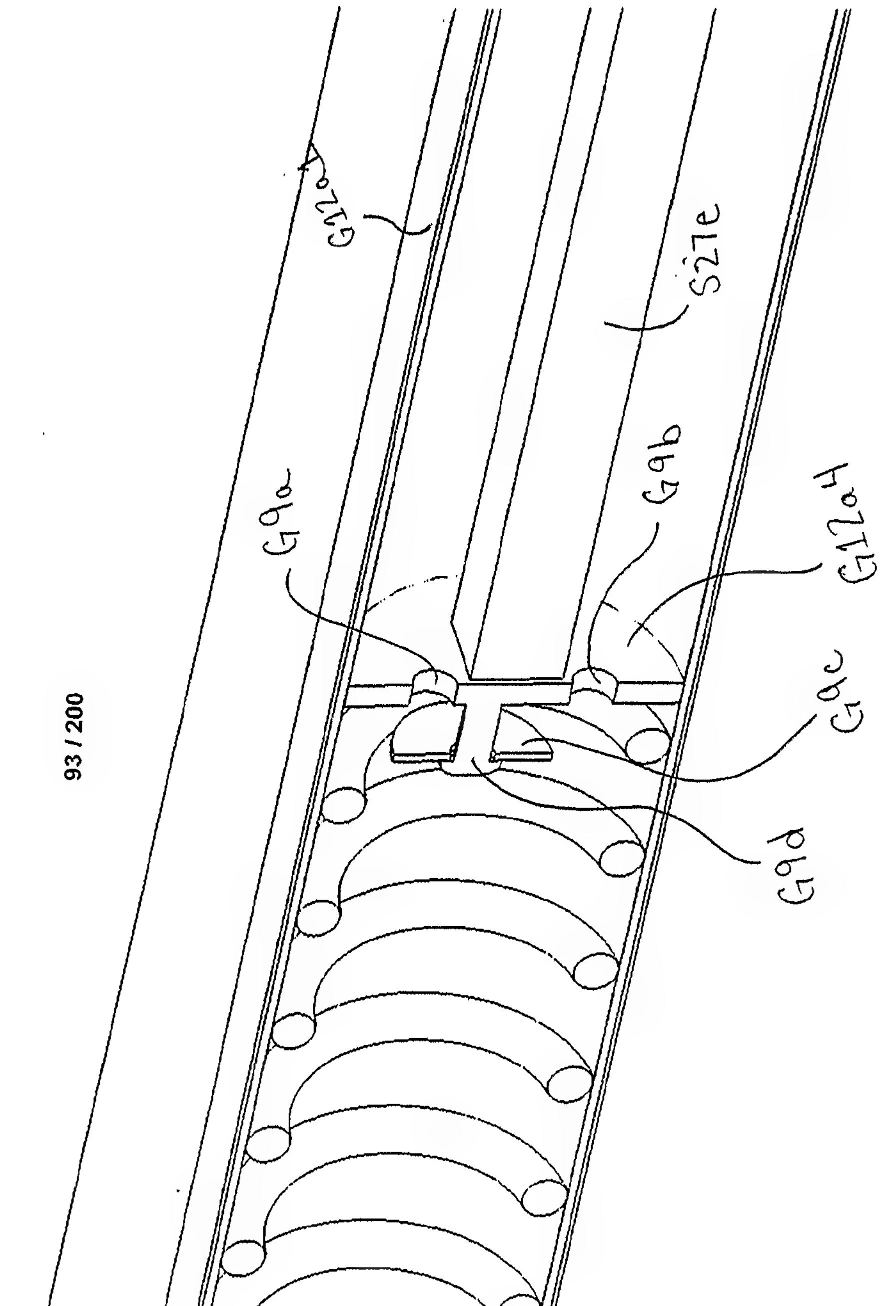
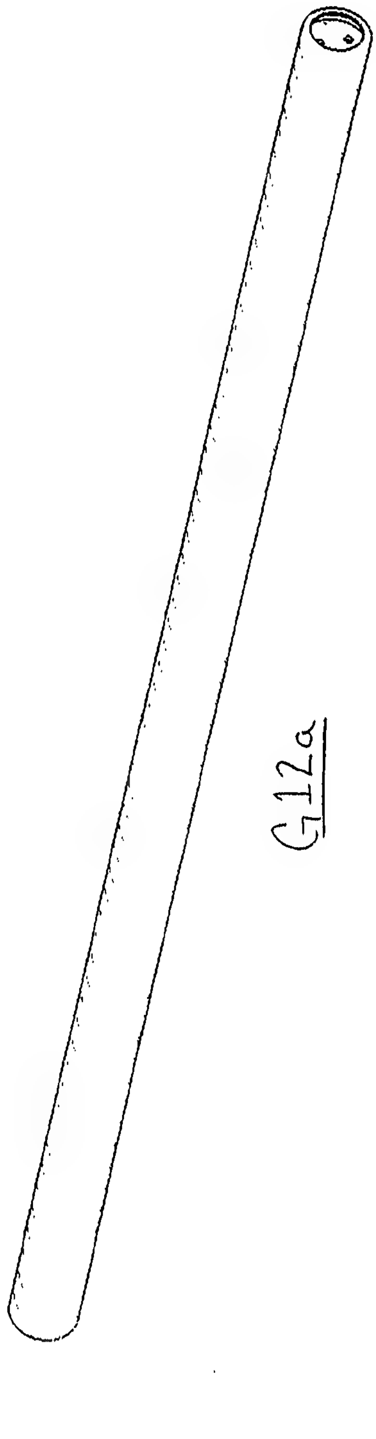


FIG. G11



G12a

FIG. G12

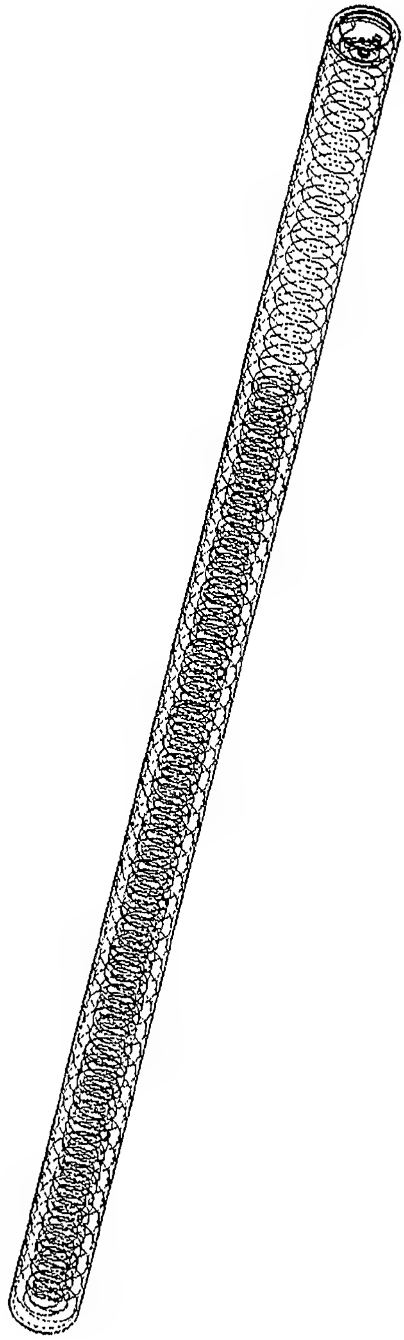


FIG. G13

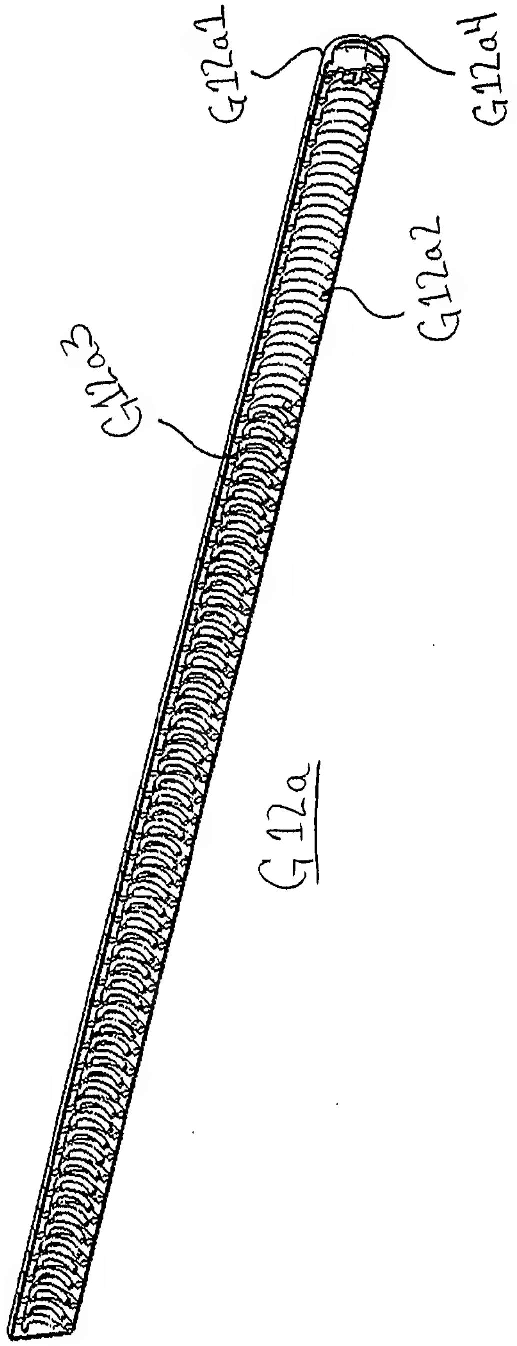


FIG. G14

FIG. G15

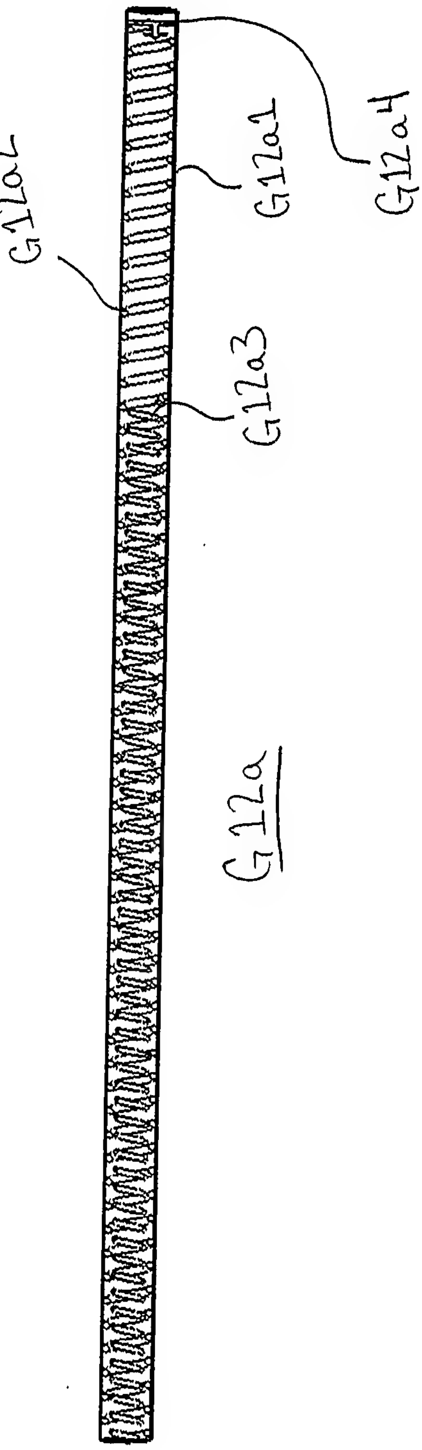
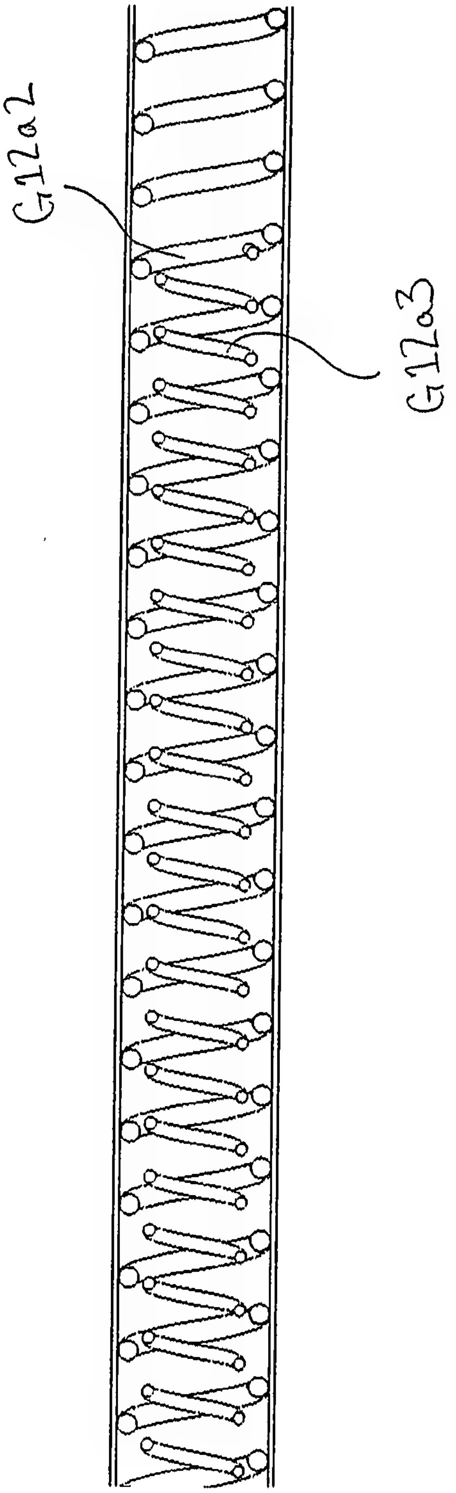


FIG. G16



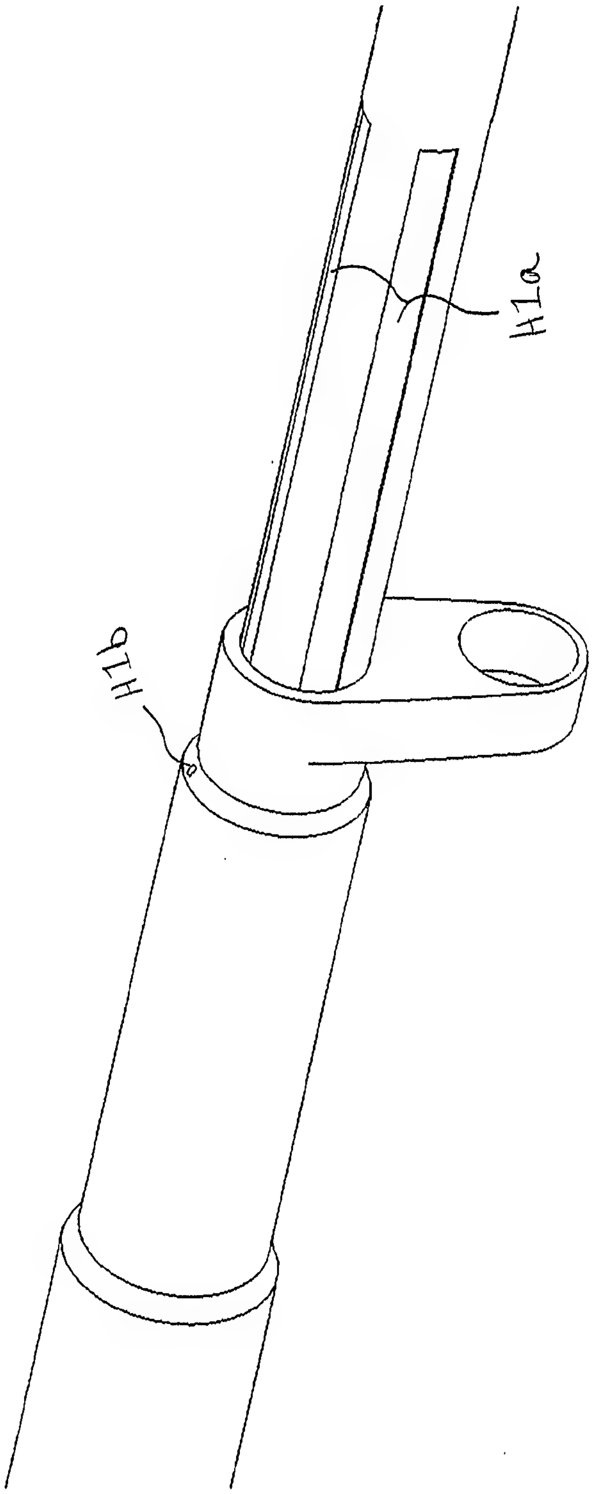


FIG. H1

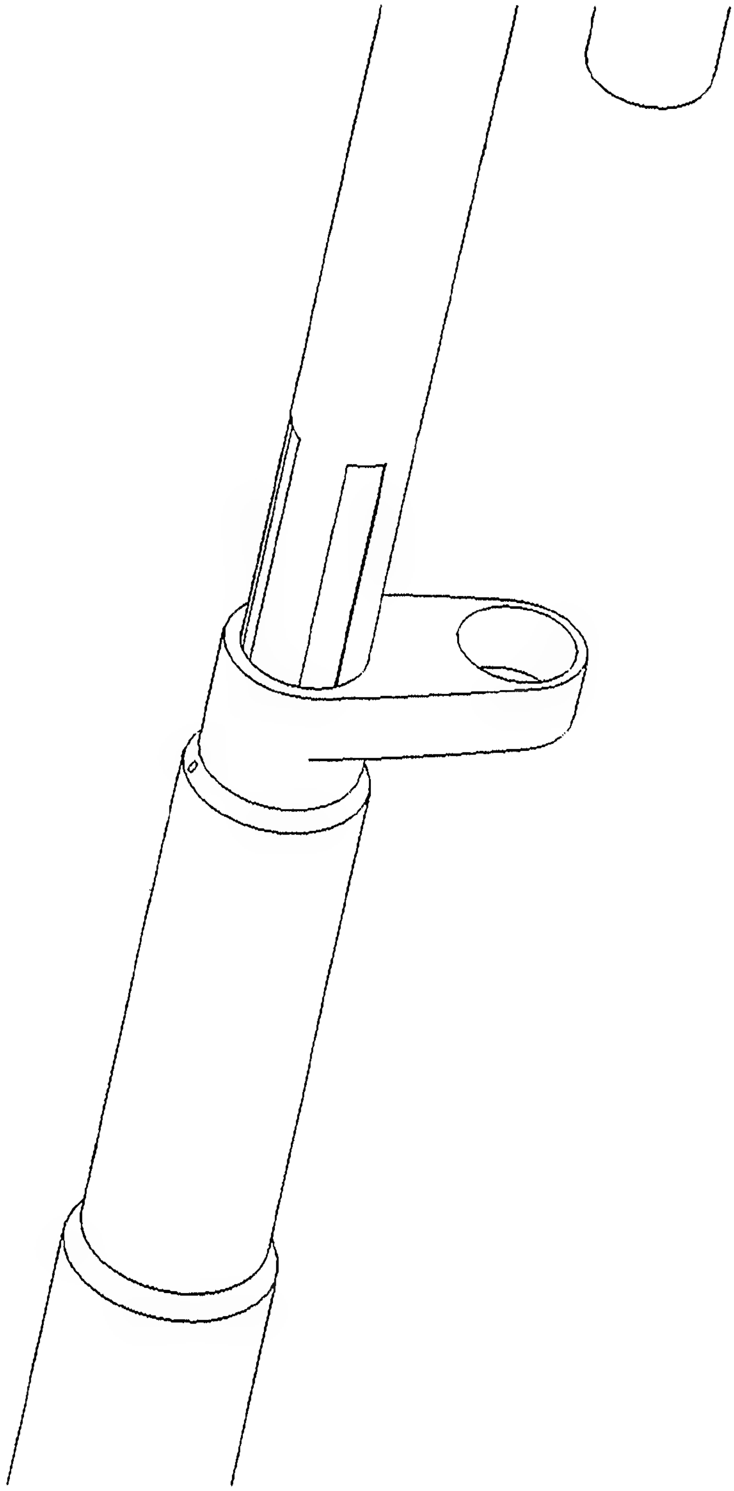


FIG. H2

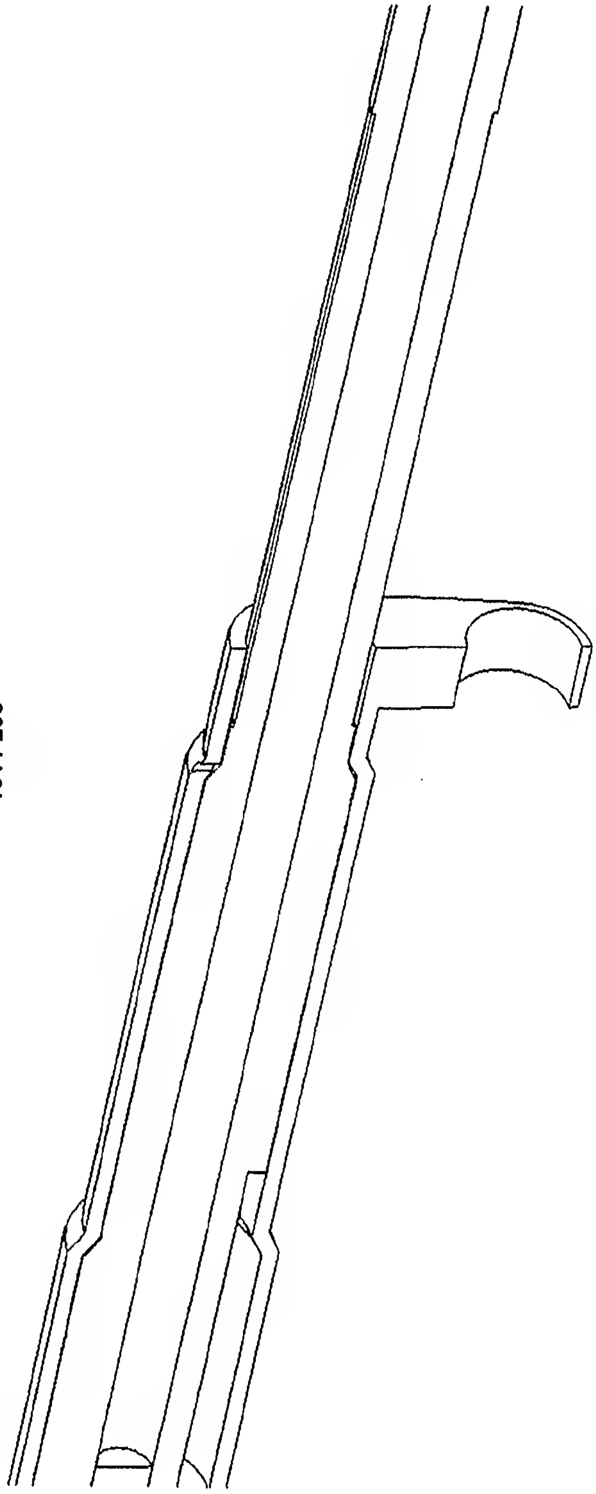


FIG. H3

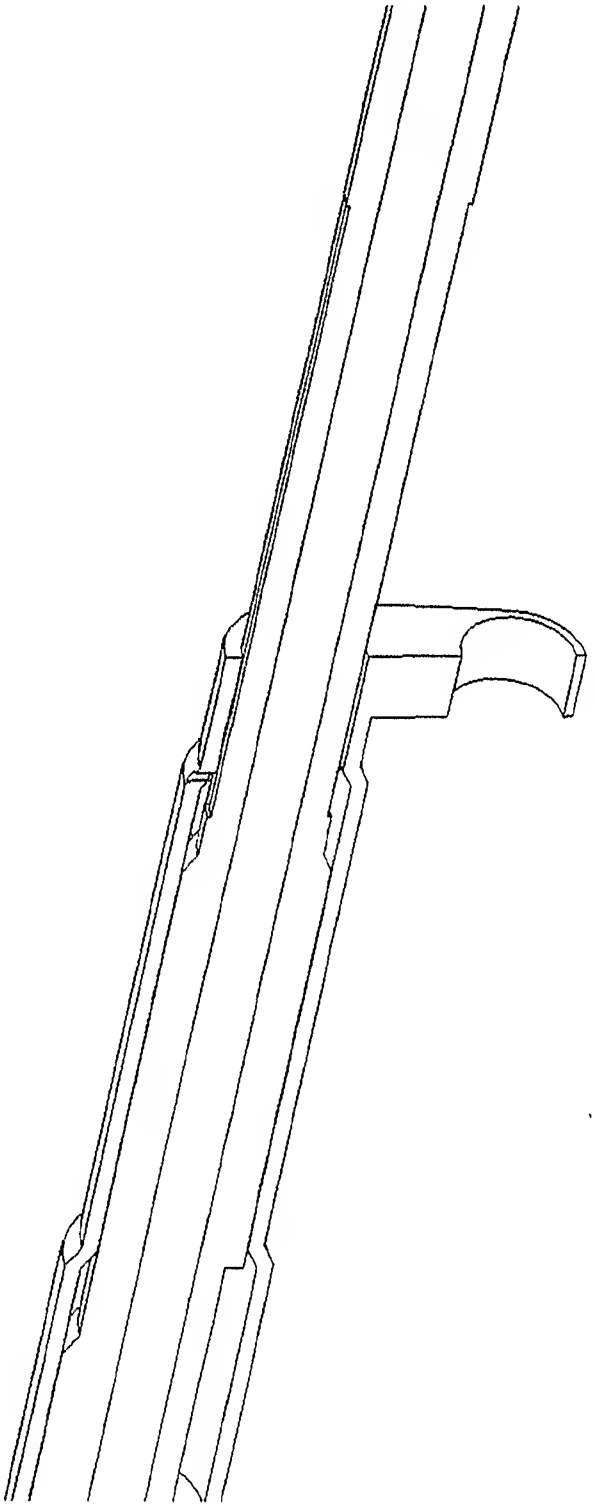
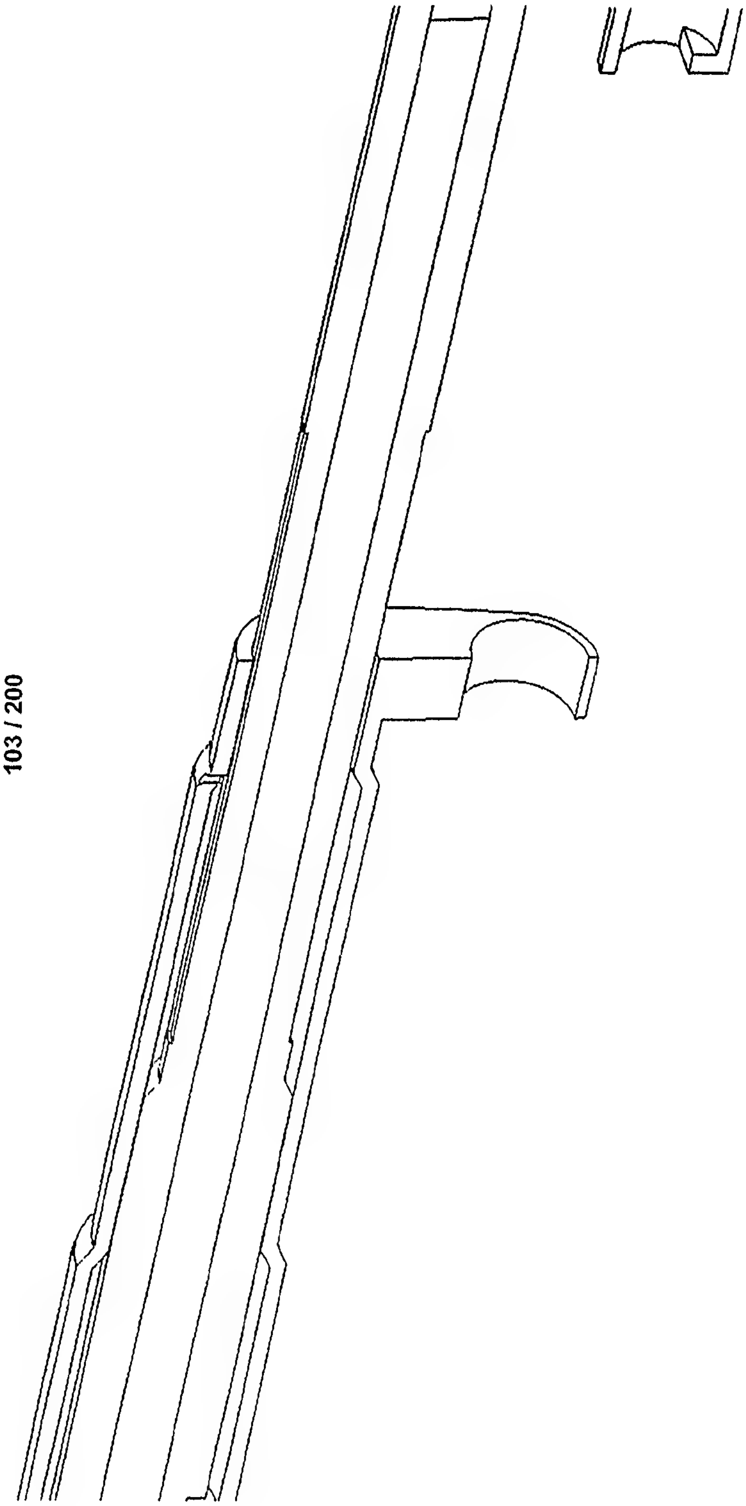


FIG. H4

FIG. H5



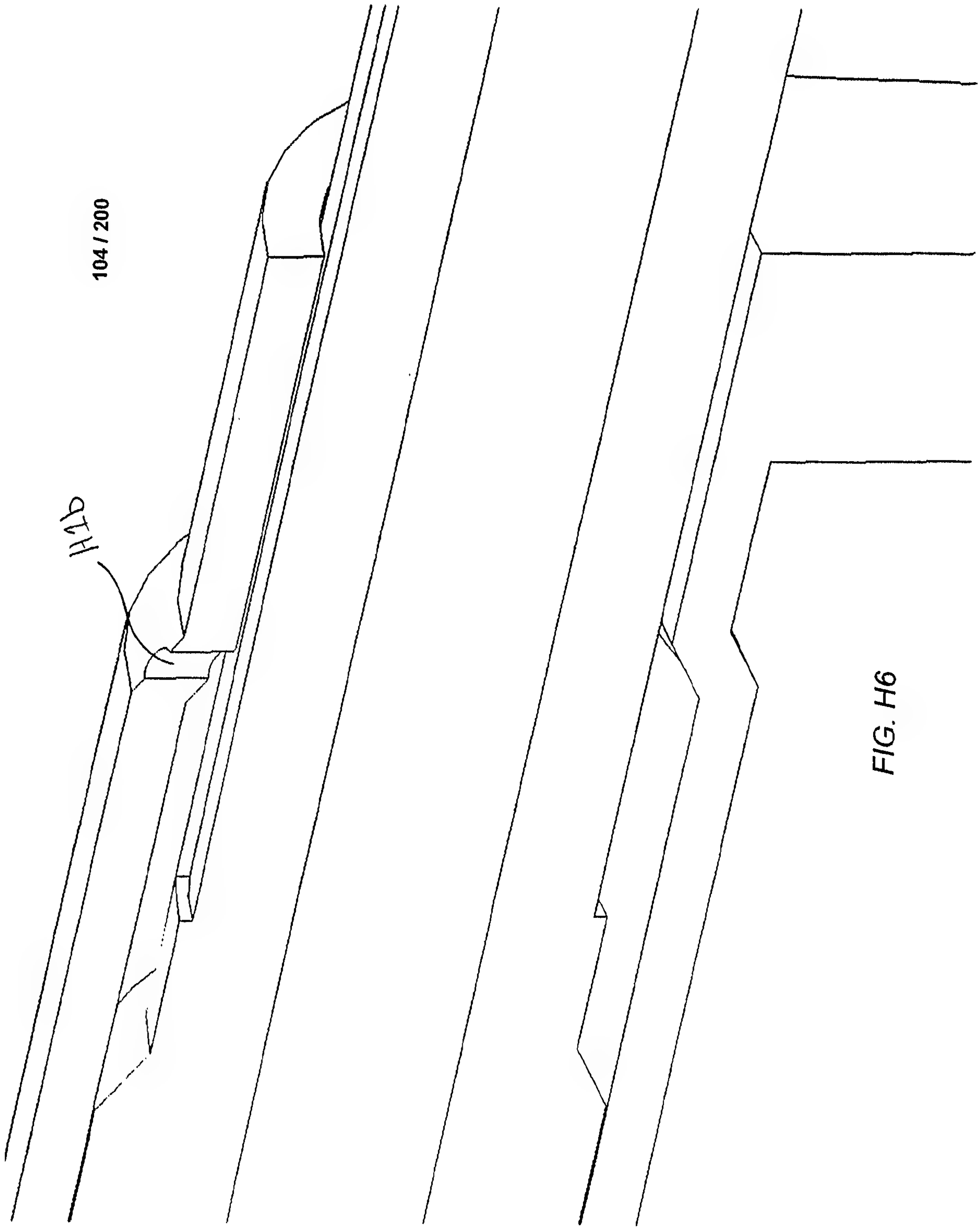


FIG. H6

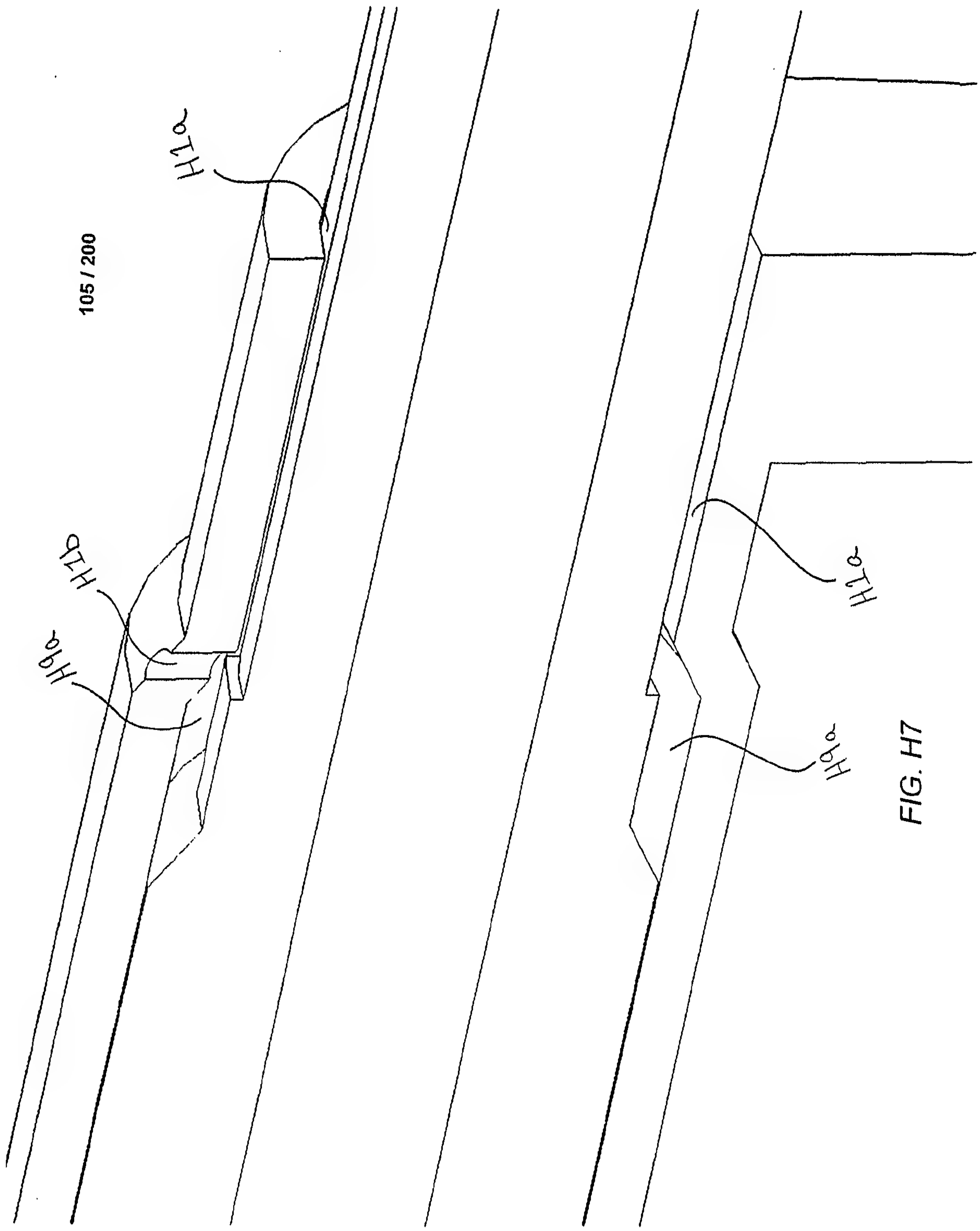


FIG. H7

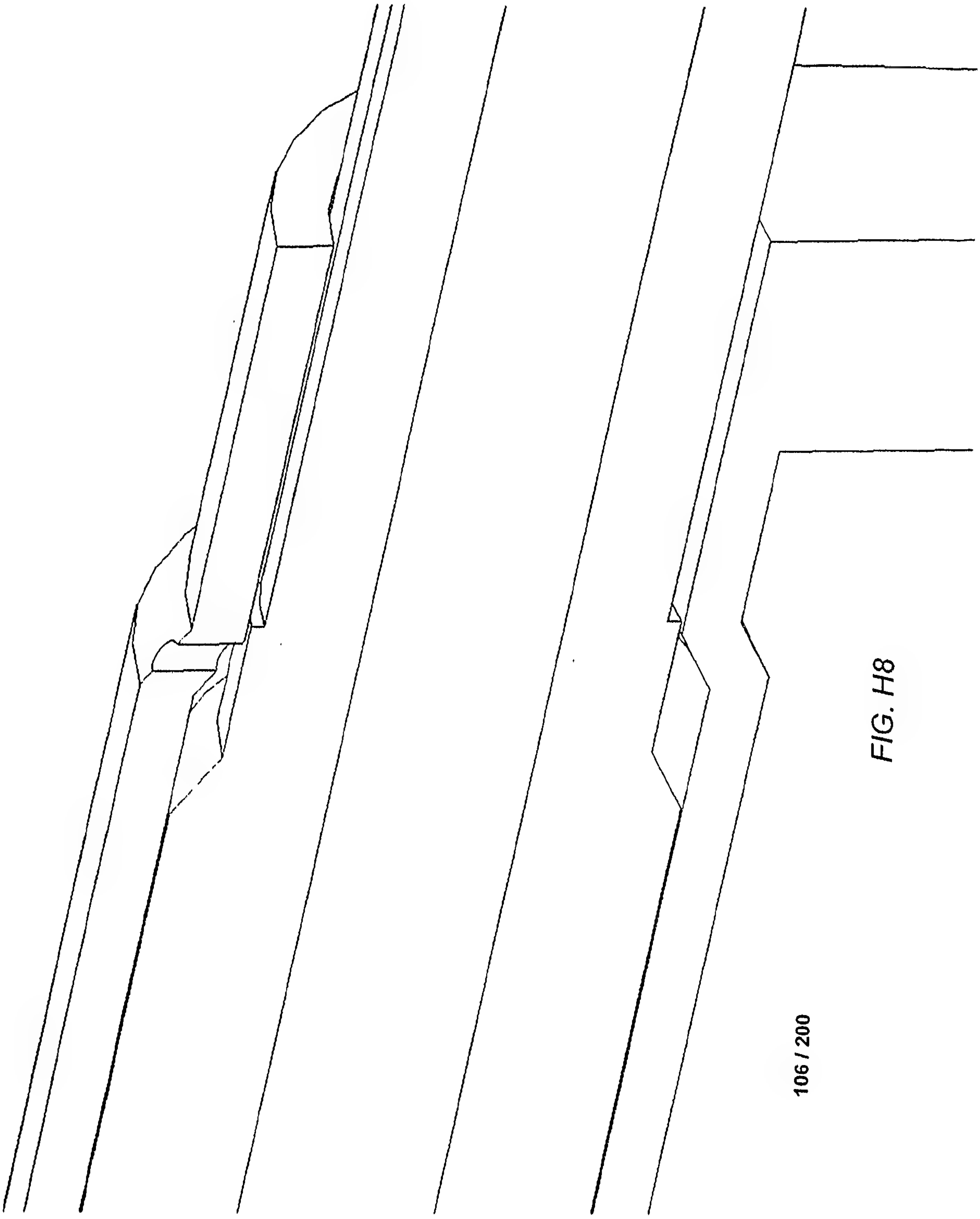


FIG. H8

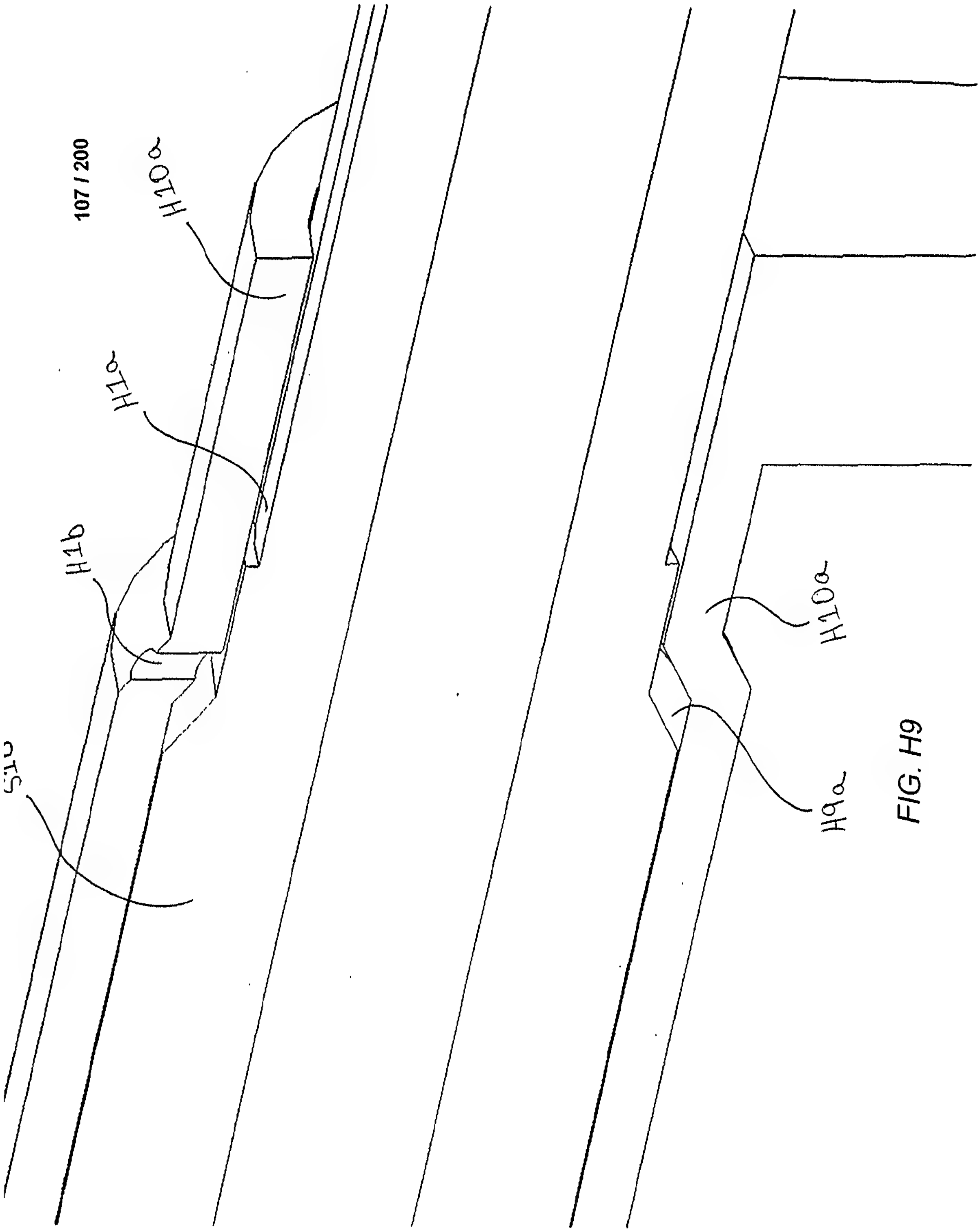


FIG. H9

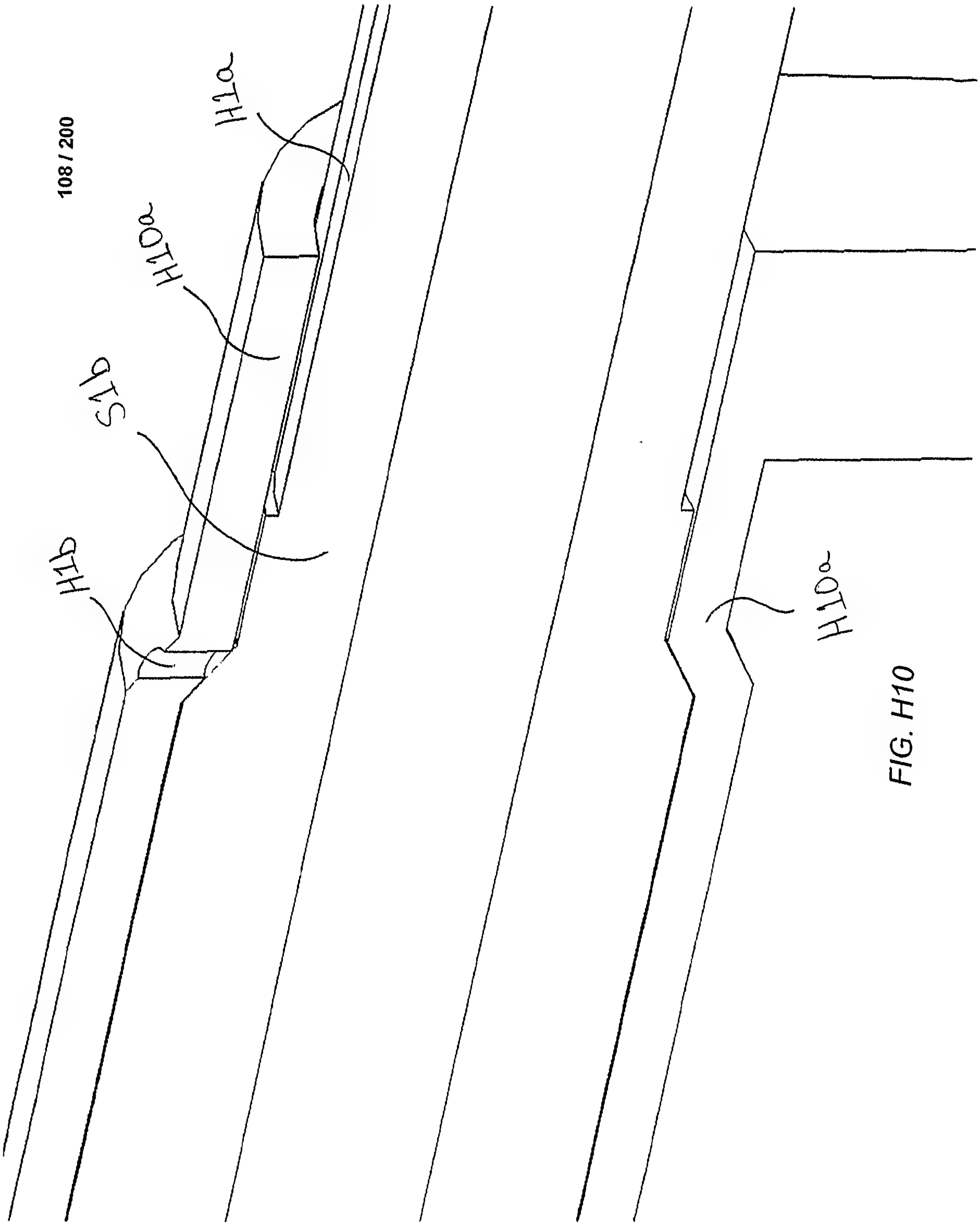


FIG. H10

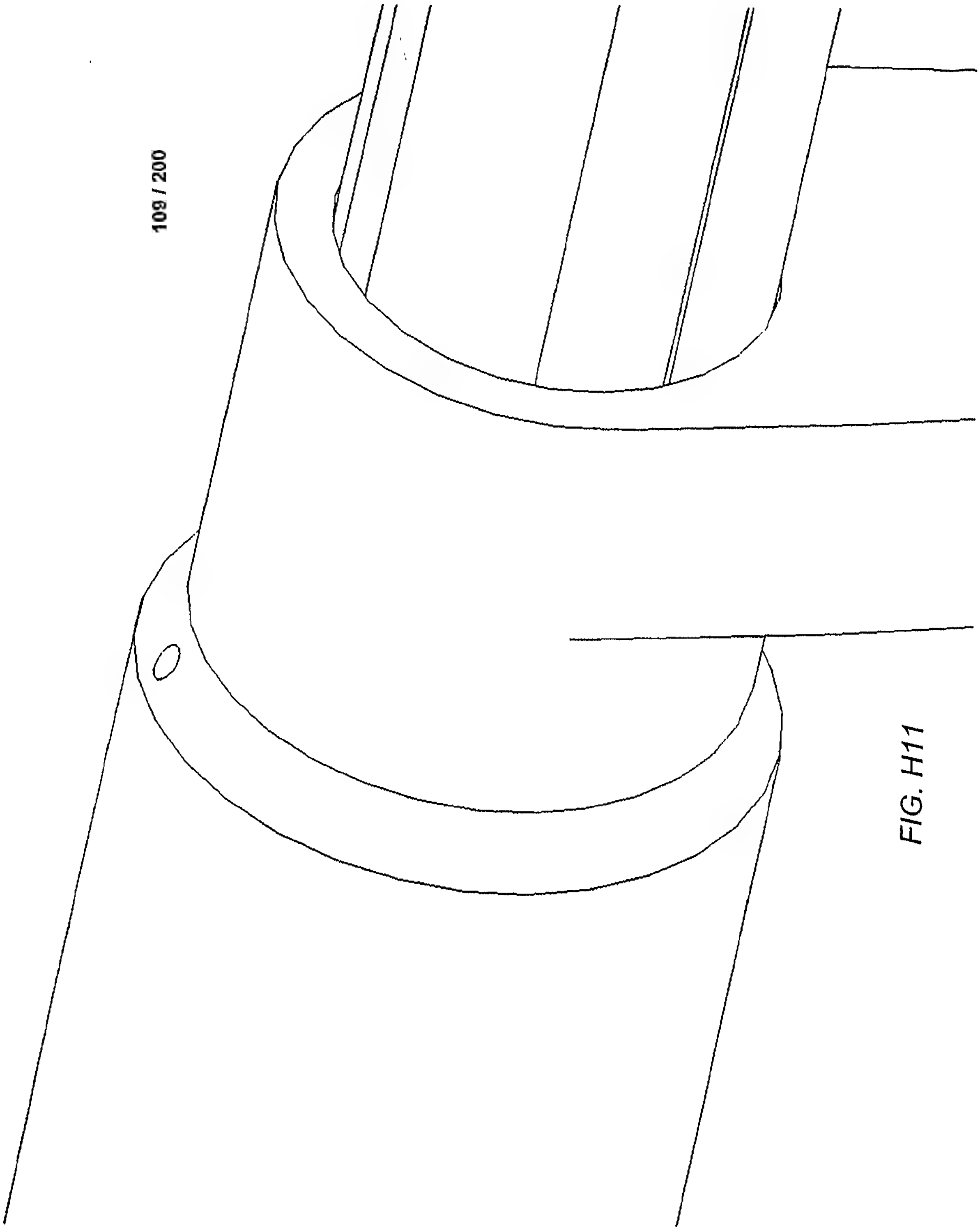
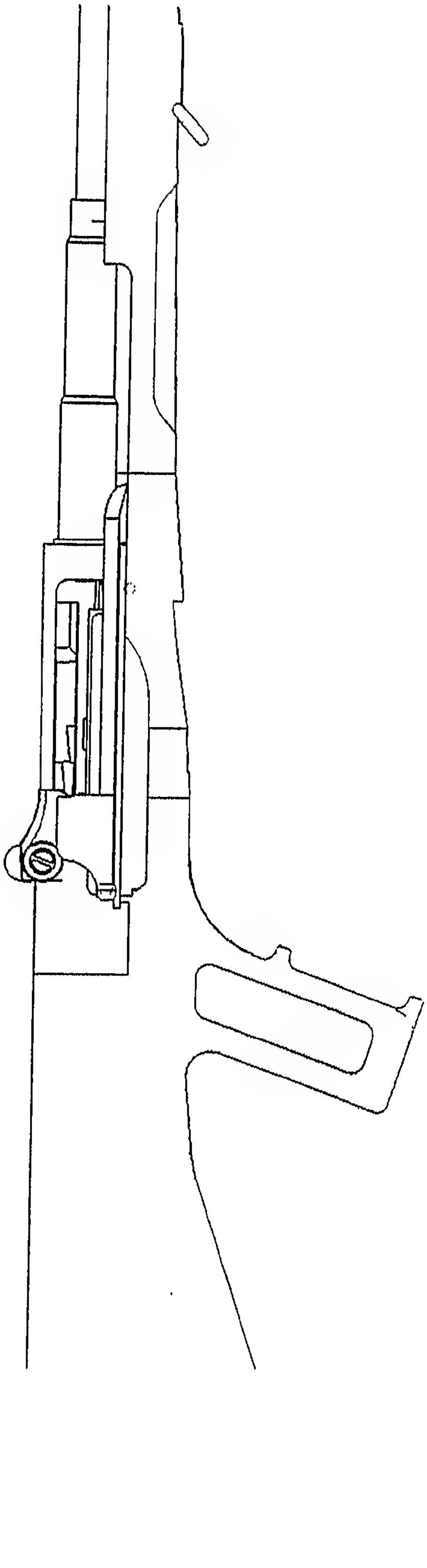


FIG. H11

FIG. L1



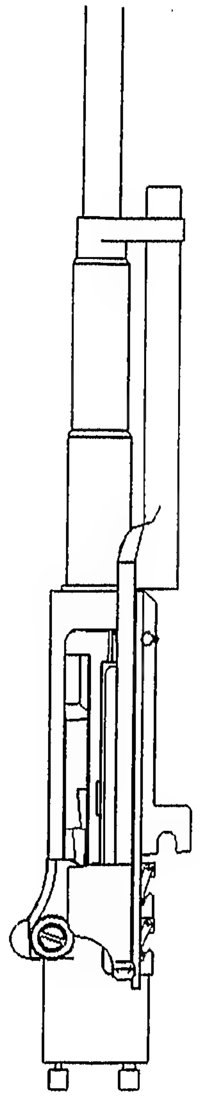


FIG. L2

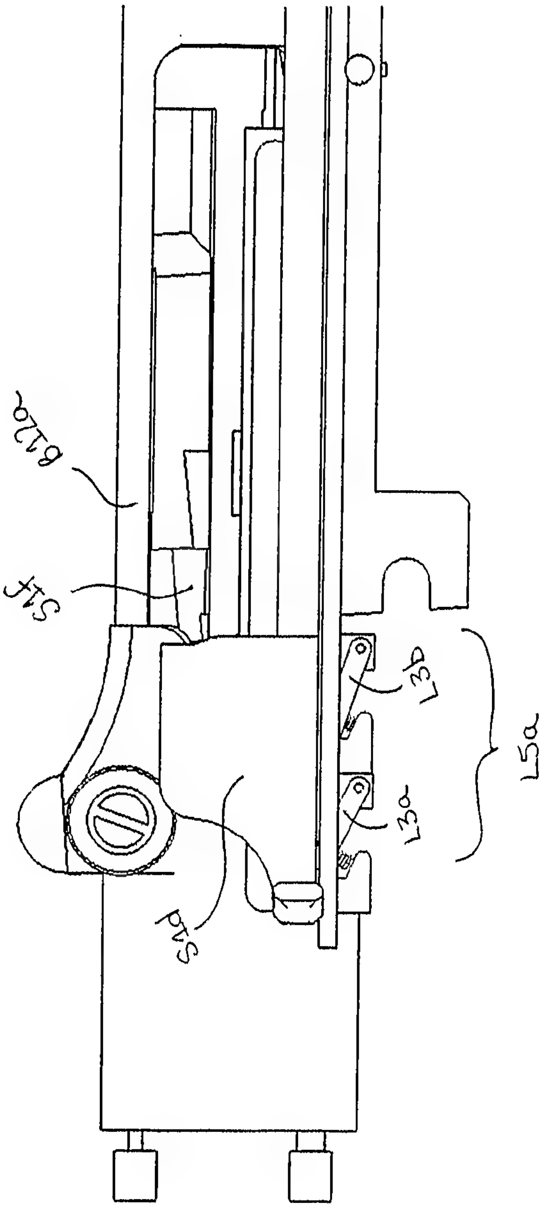


FIG. L3

Infan

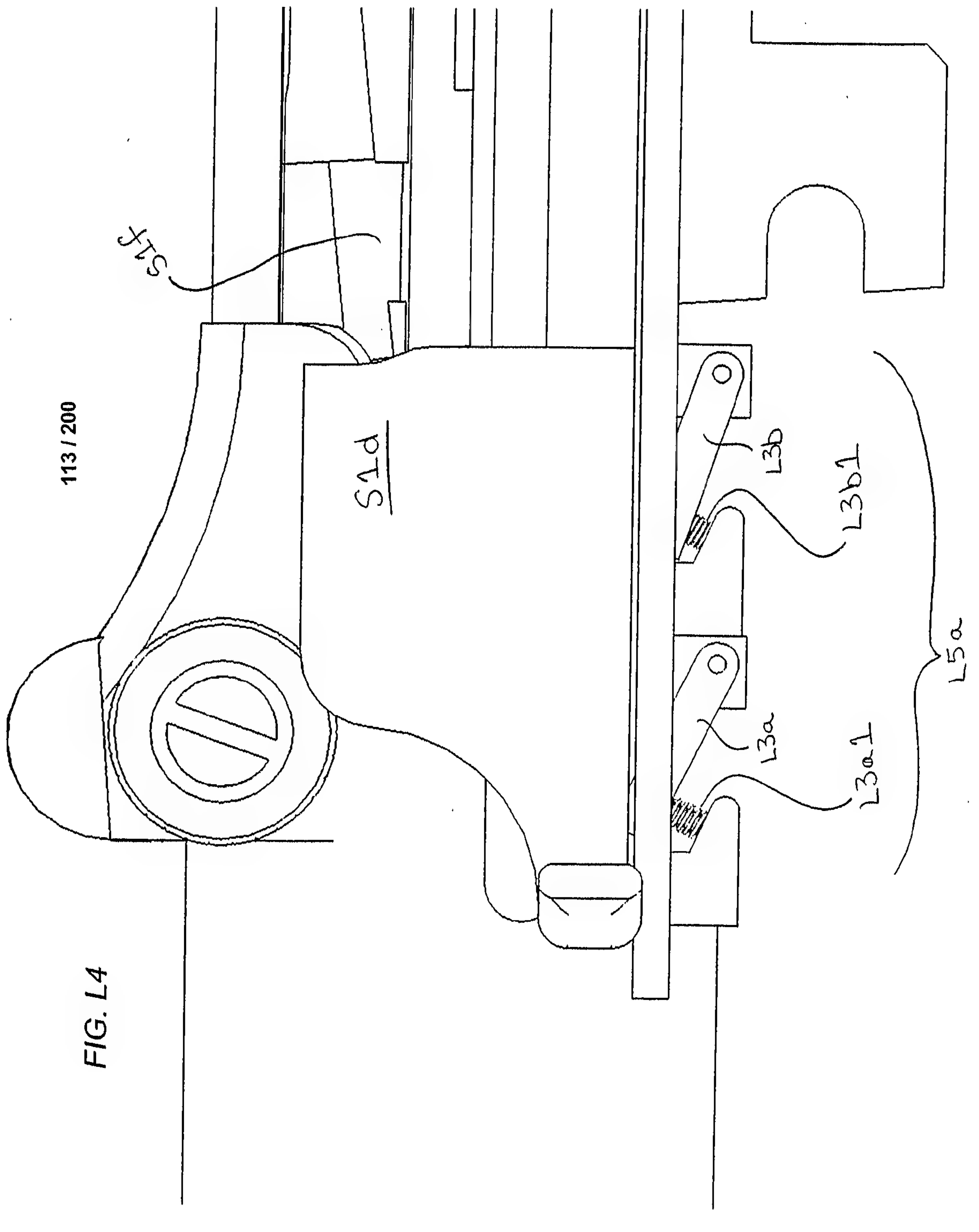


FIG. L4

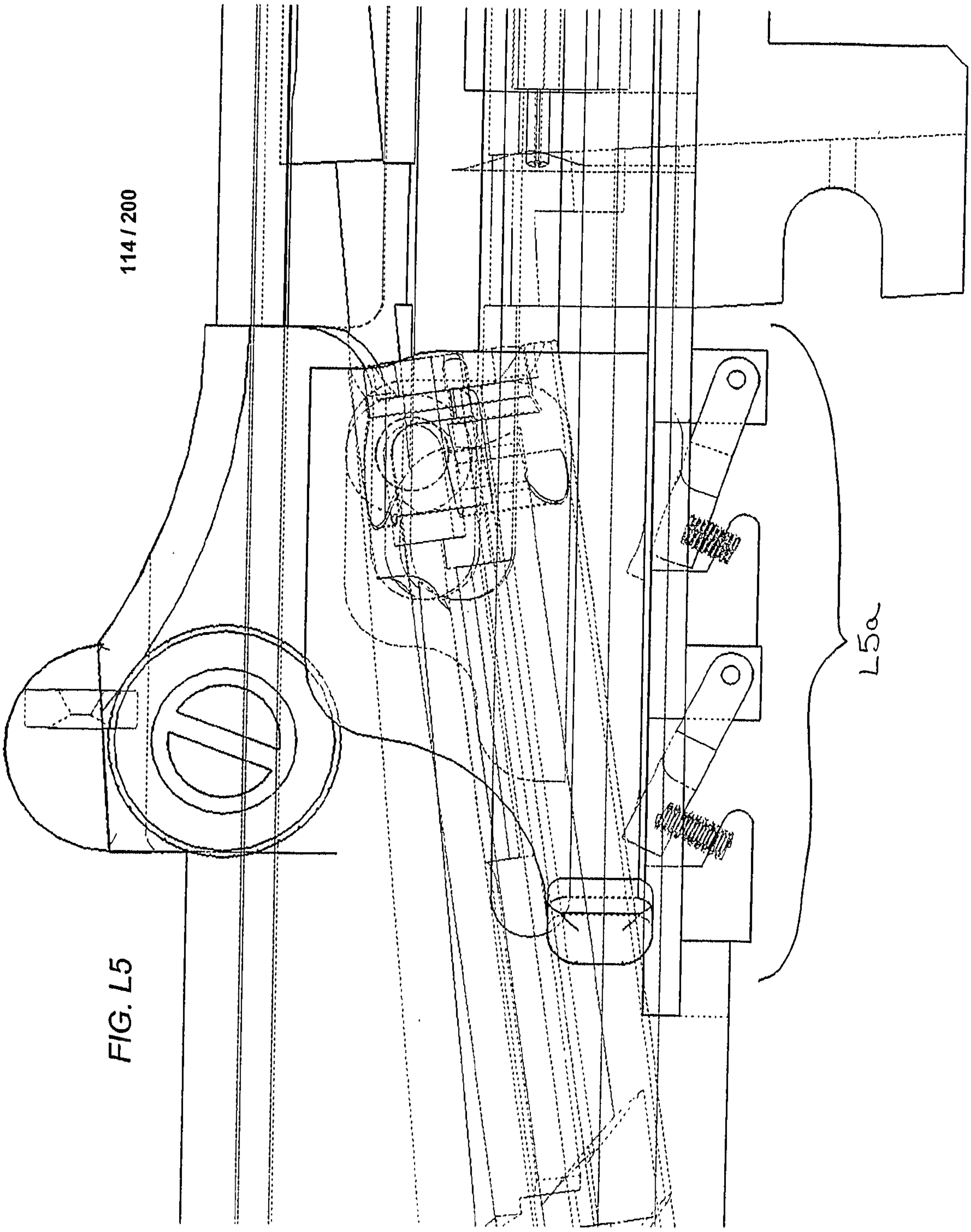


FIG. L5

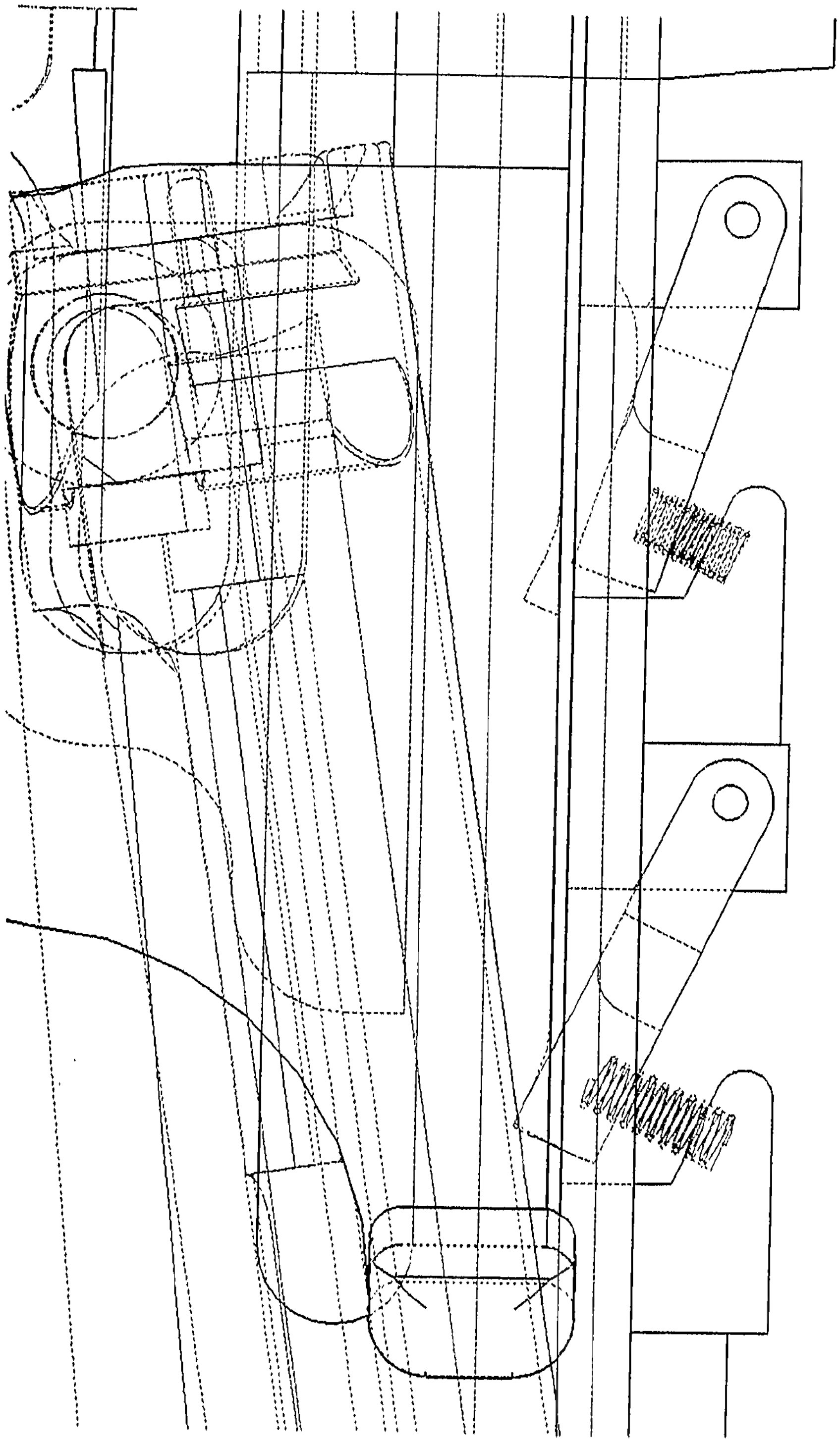


FIG. L6

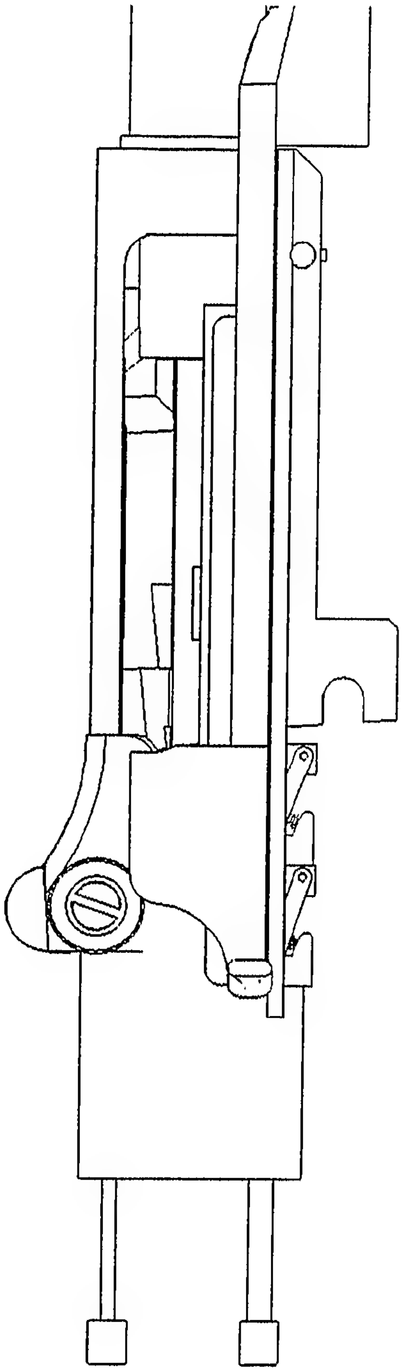


FIG. L7

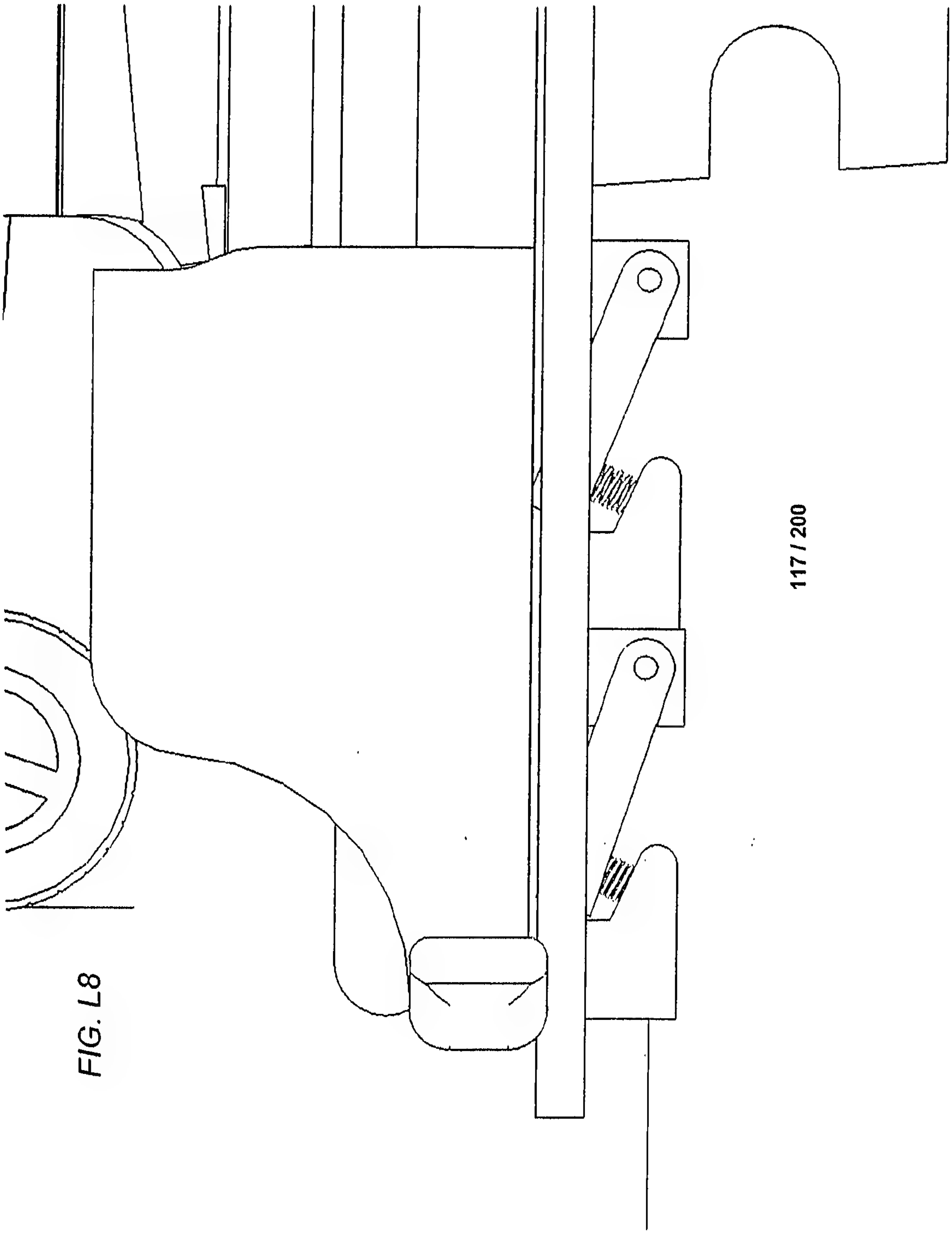


FIG. L8

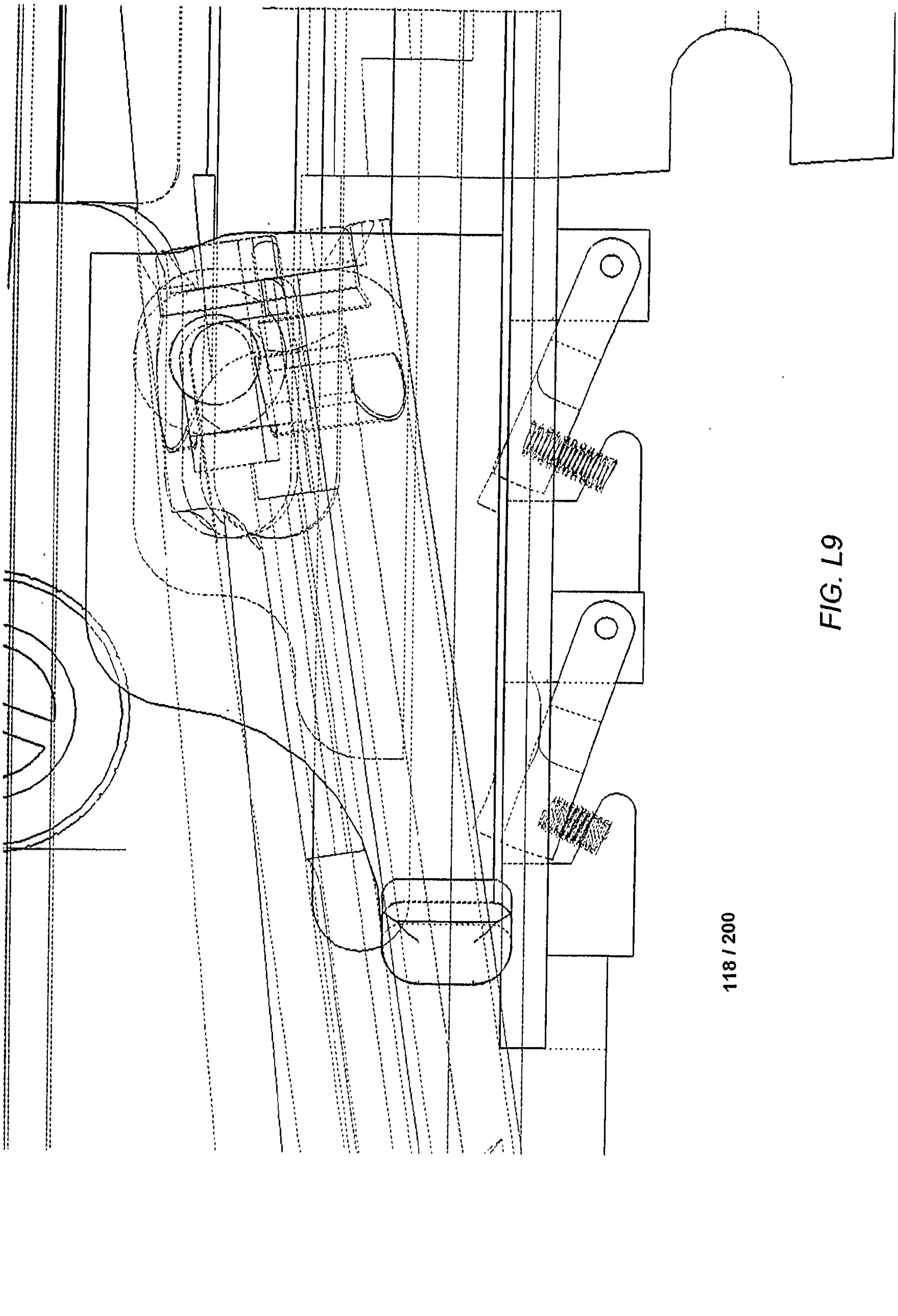


FIG. L9

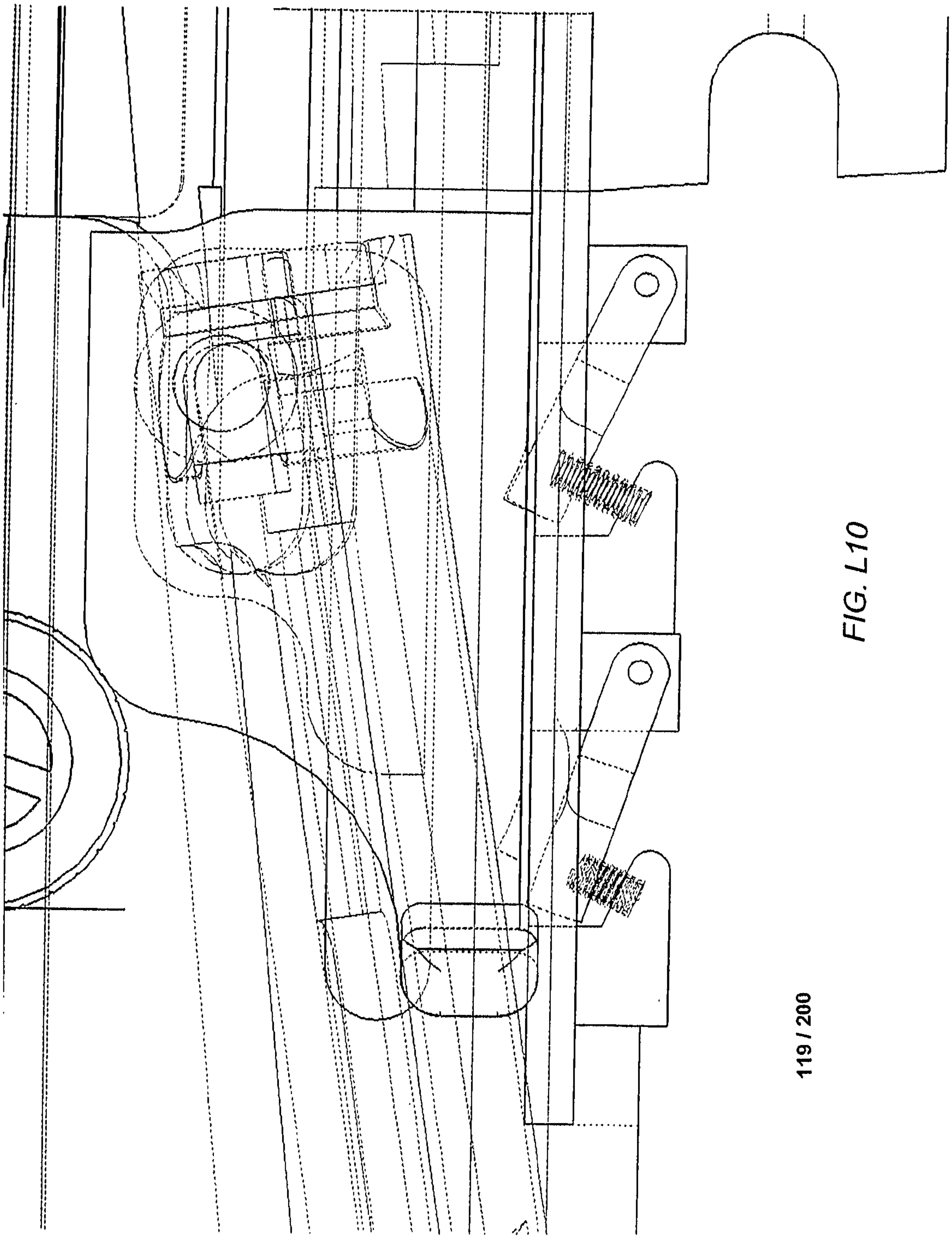


FIG. L10

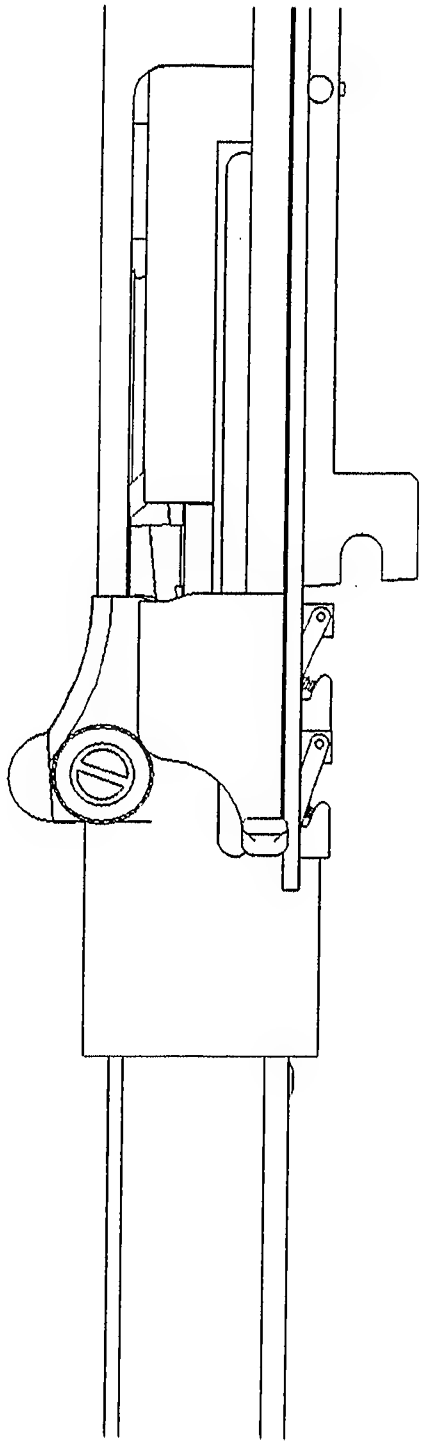


FIG. L11

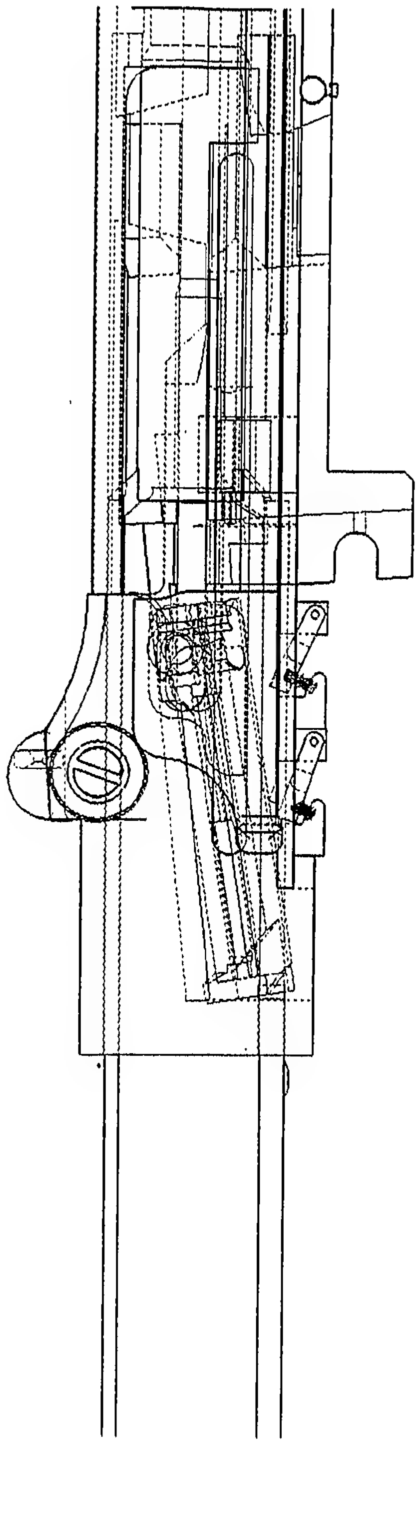


FIG. L12

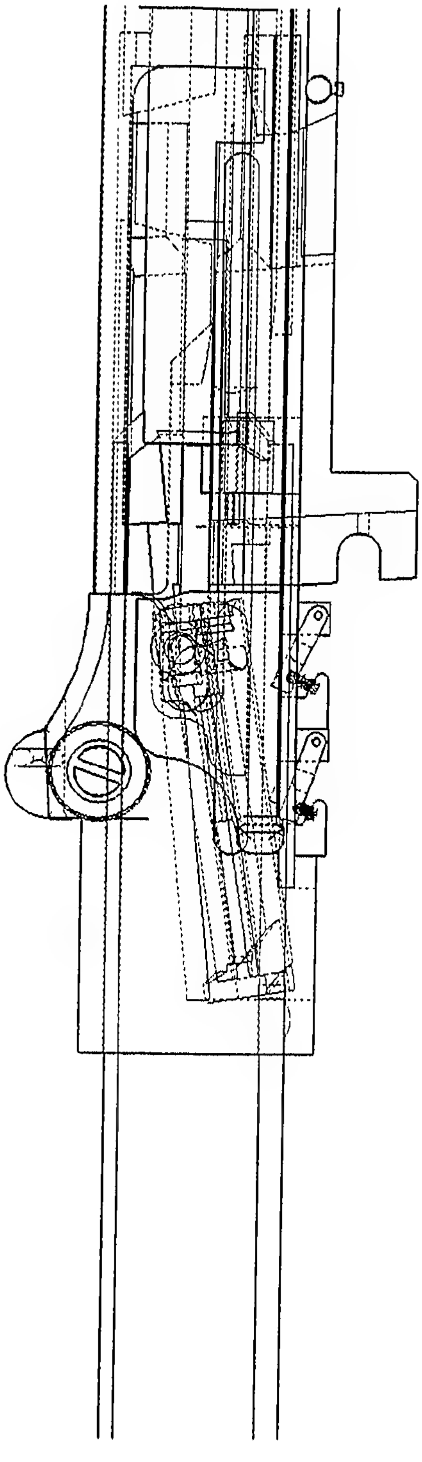


FIG. L13

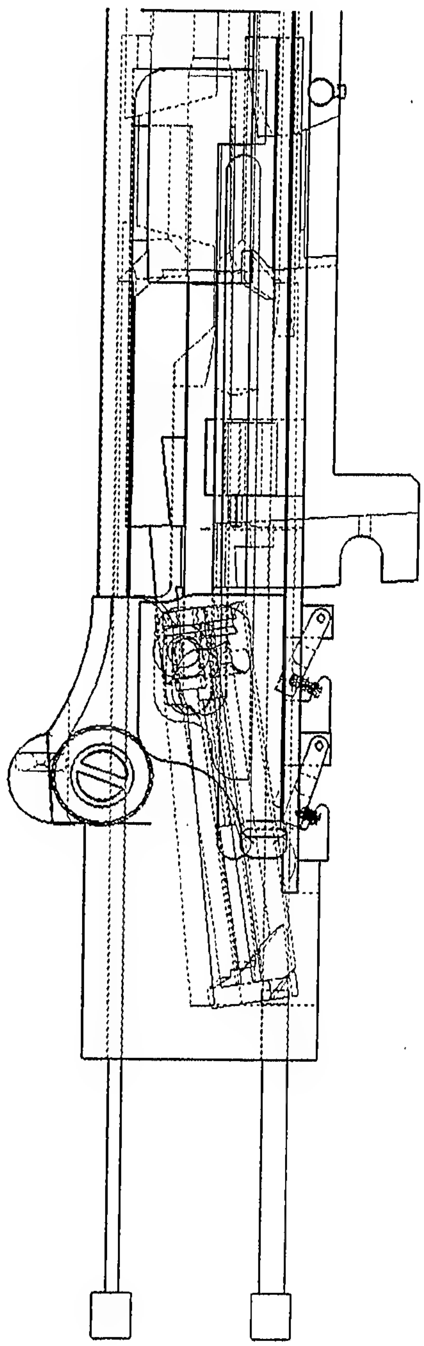


FIG. L14

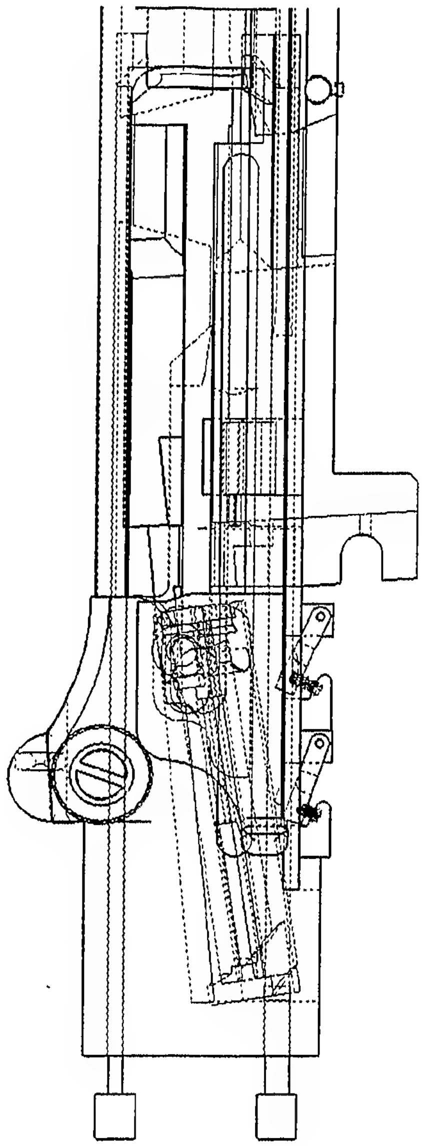


FIG. L15

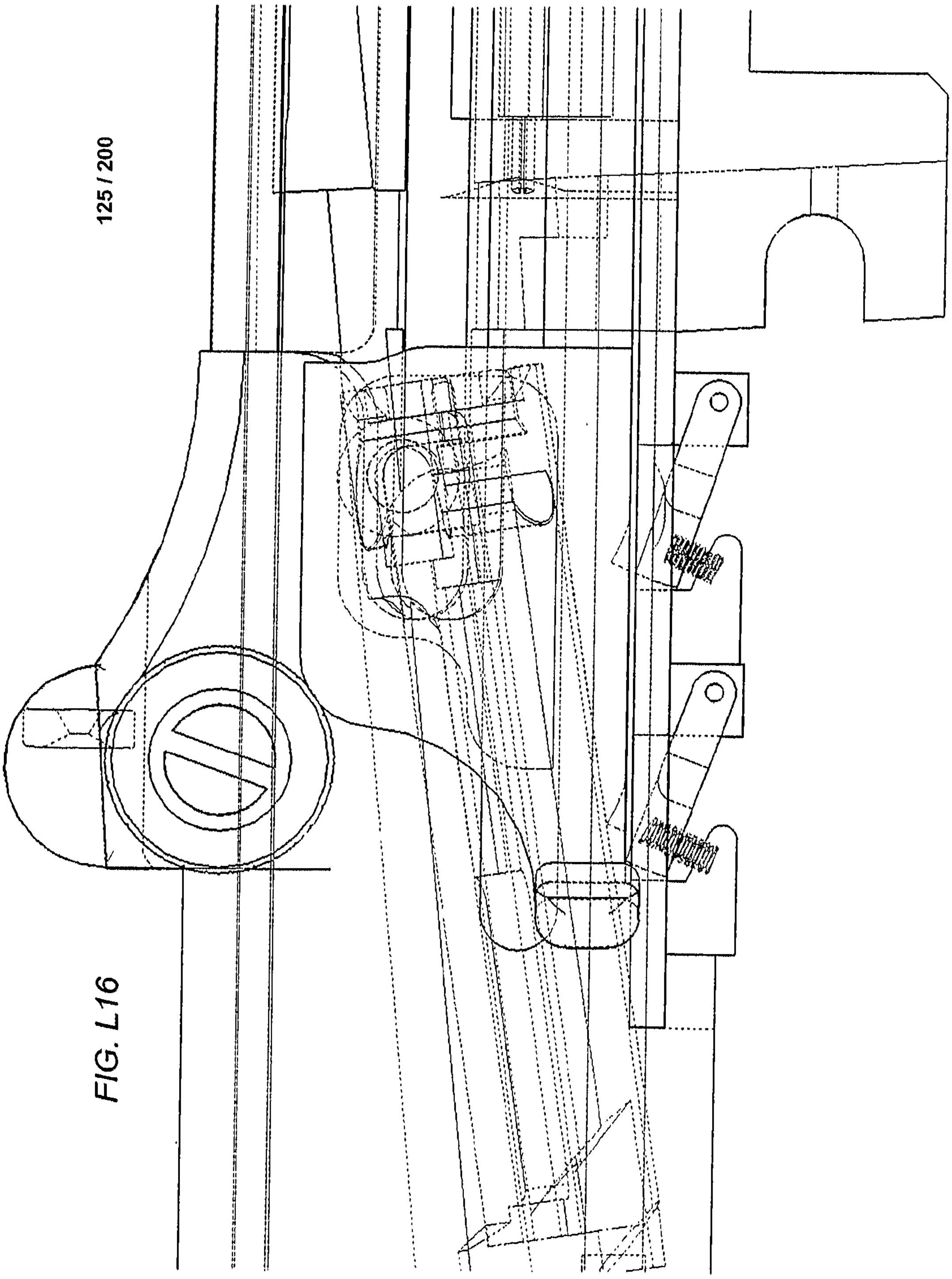


FIG. L16

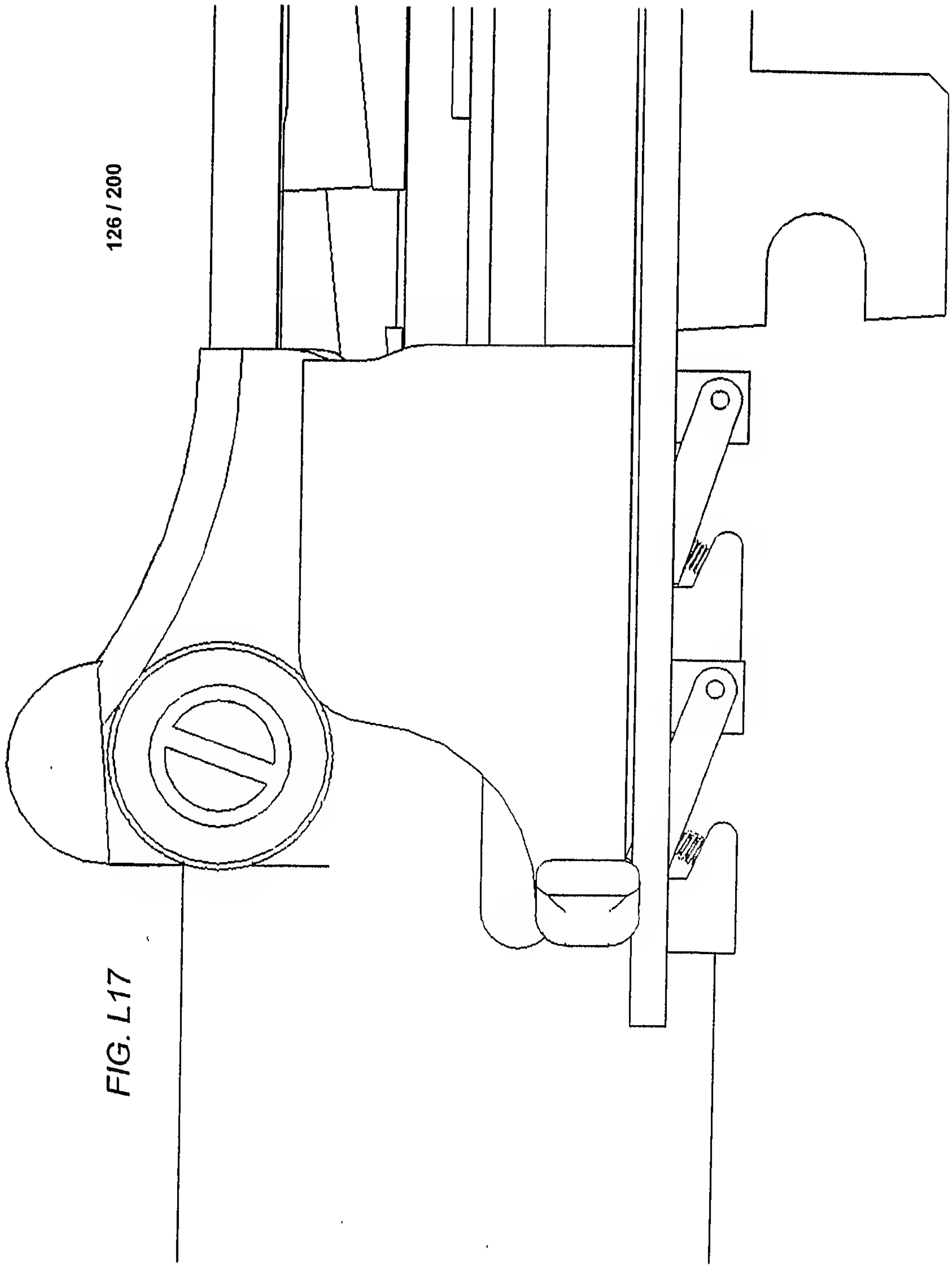


FIG. L17

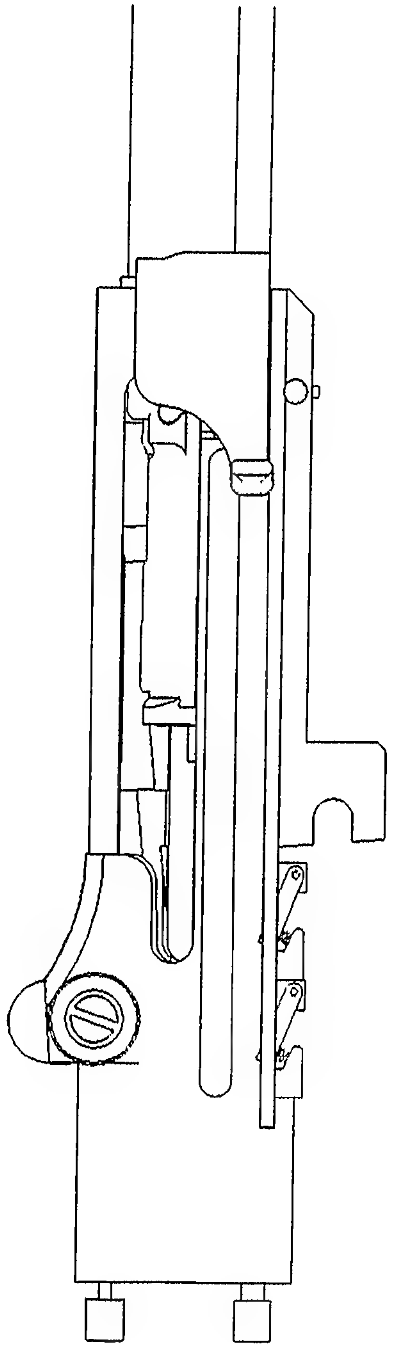
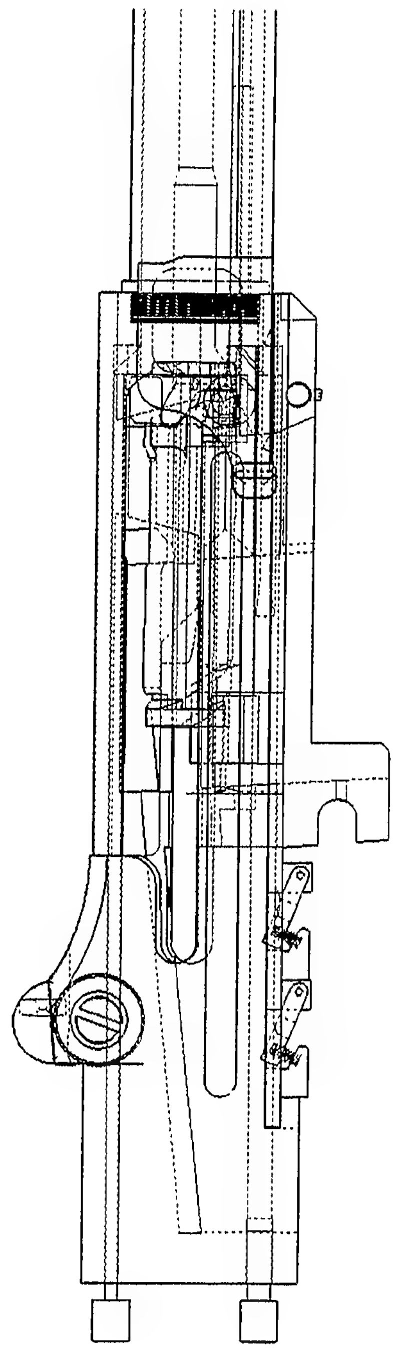


FIG. L18

FIG. L19



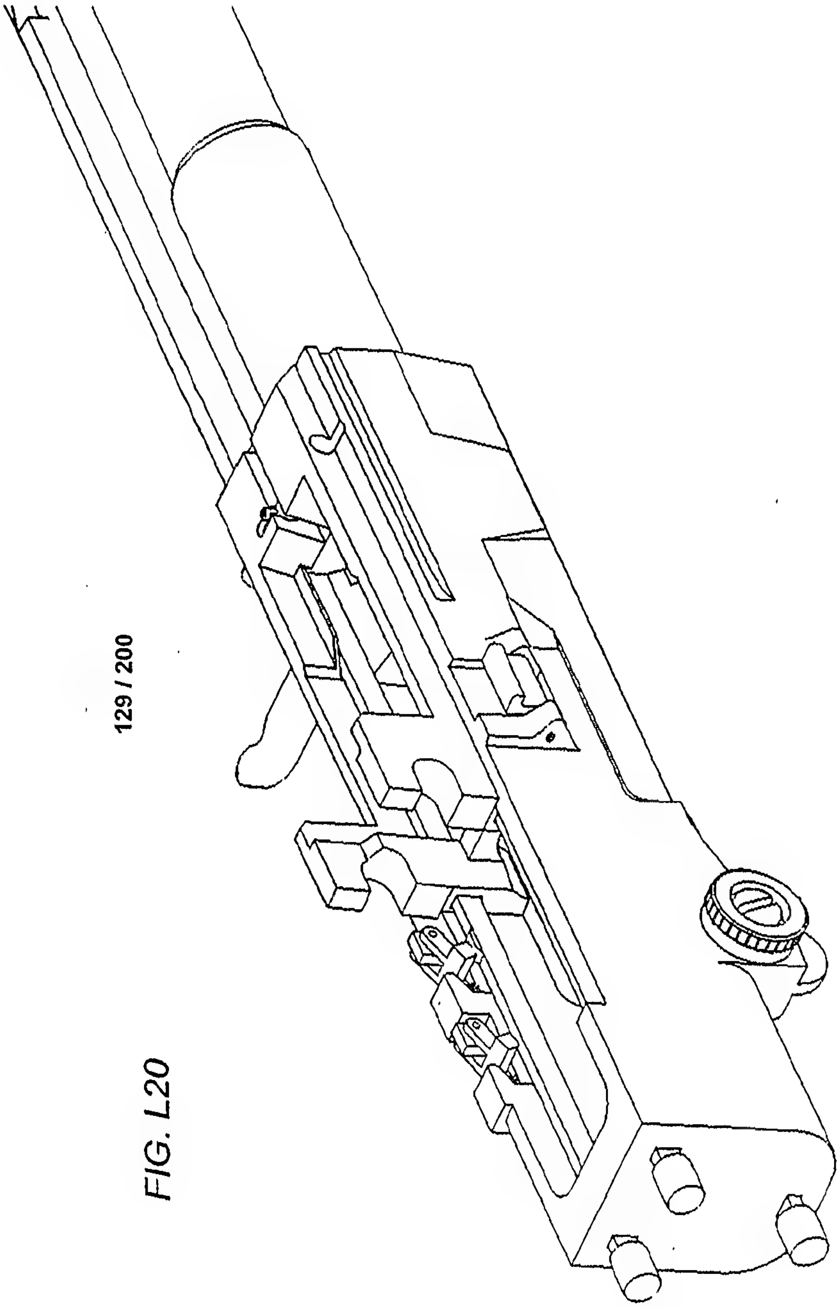
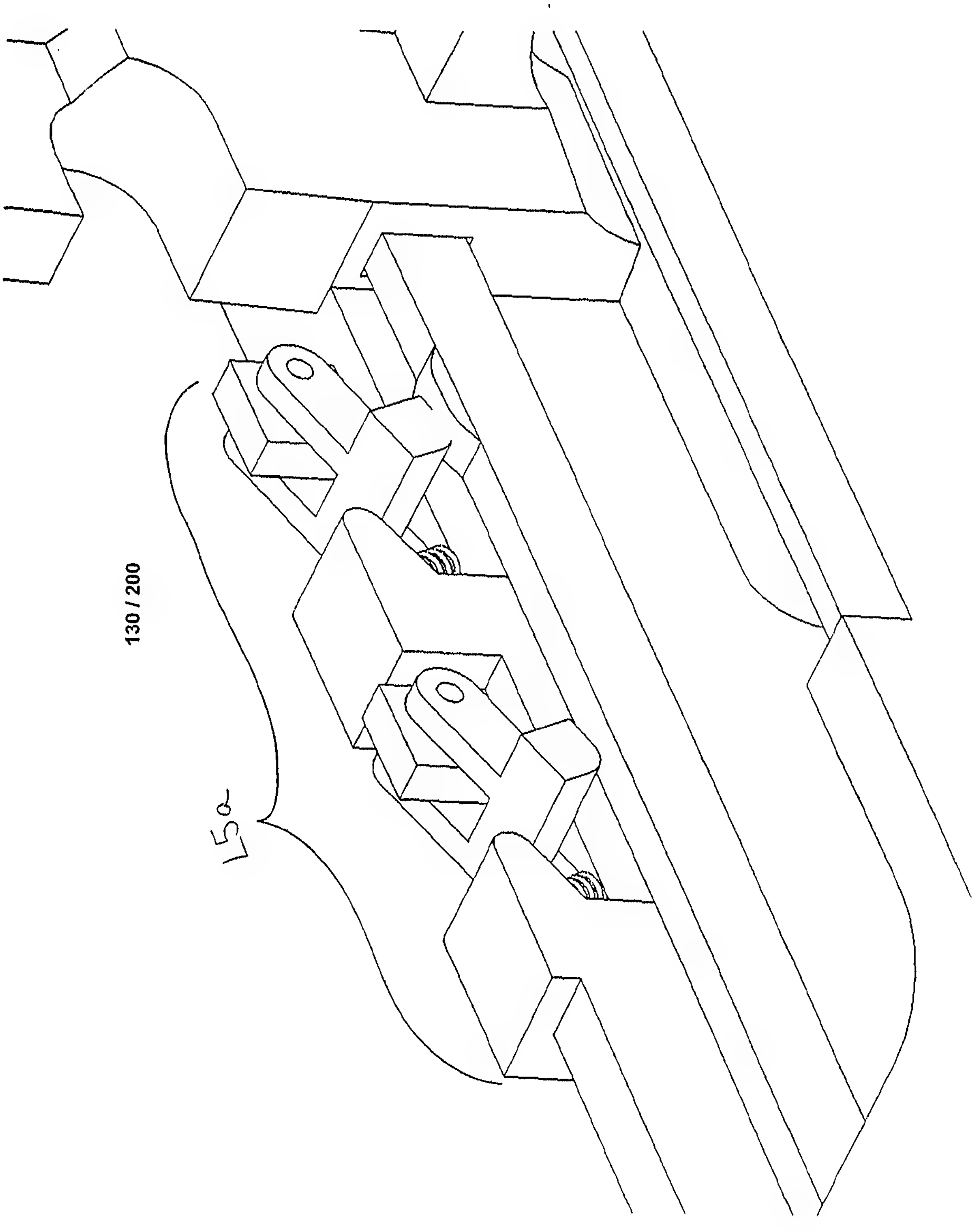


FIG. L20


5a

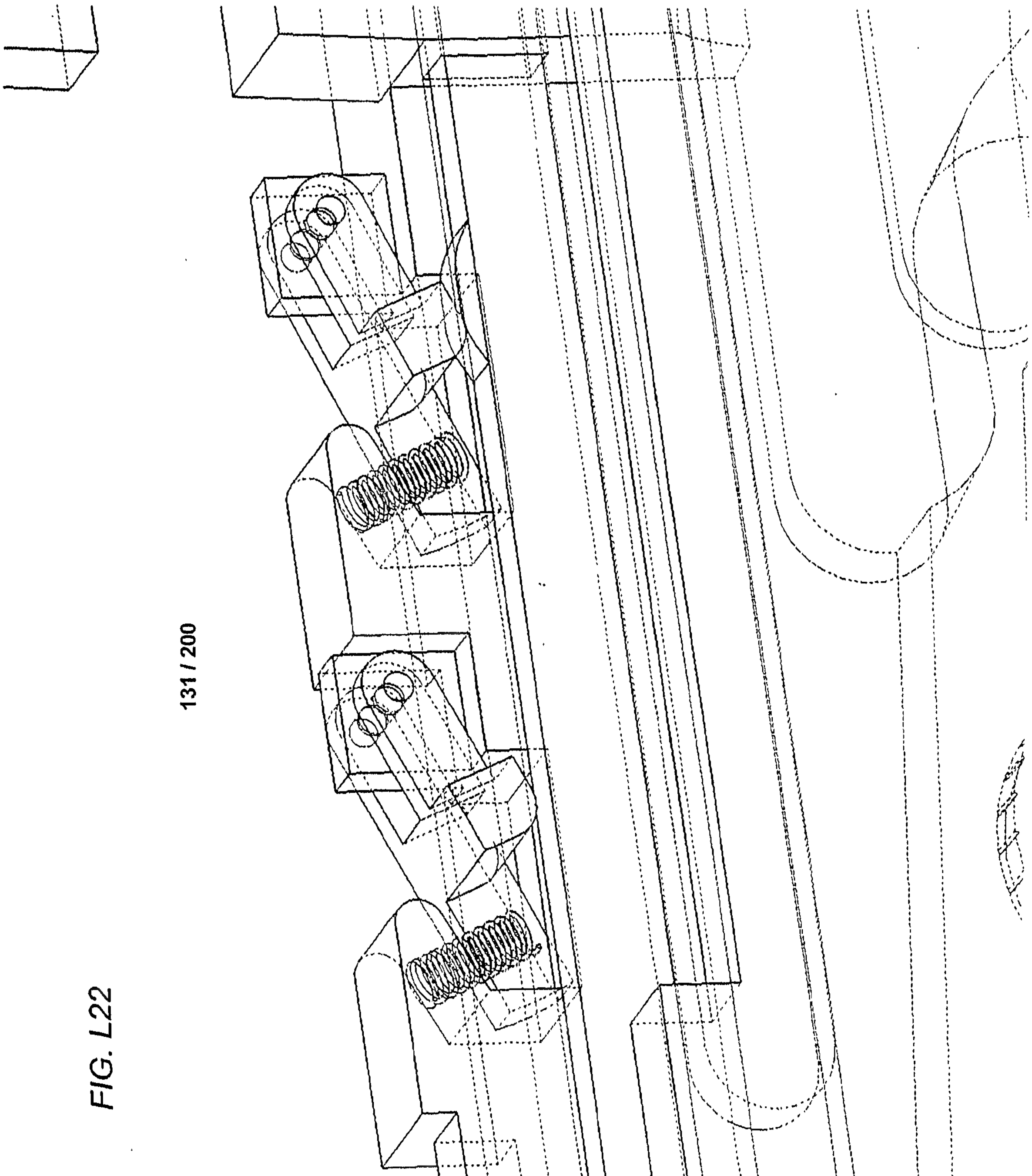


FIG. L22

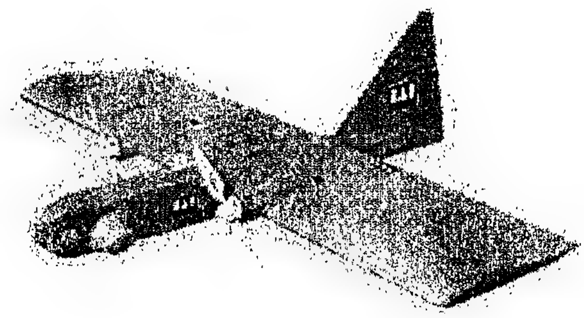


FIG. Q1a (Prior Art)

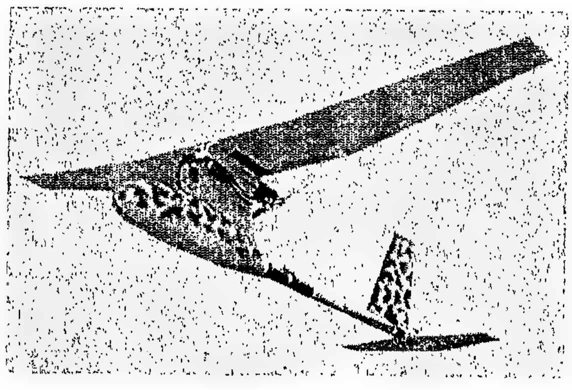


FIG. Q1b (Prior Art)

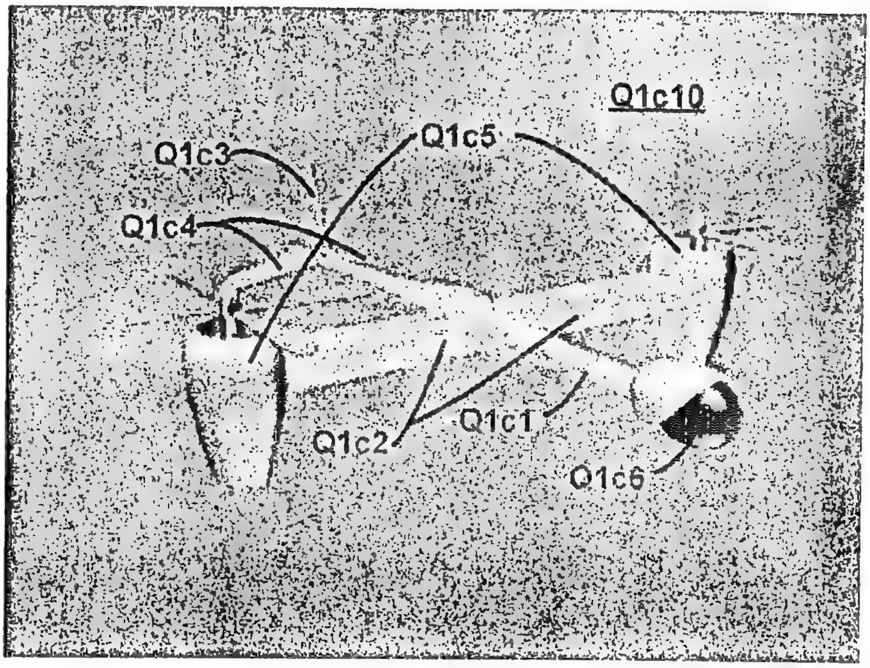


FIG. Q1c

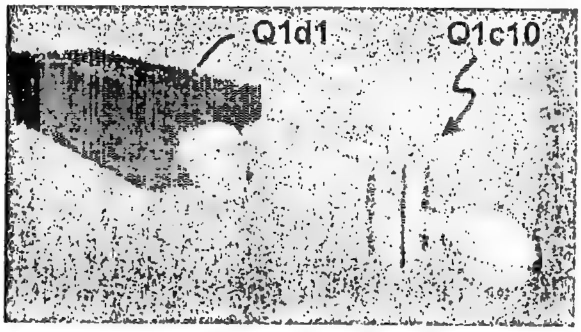


FIG. Q1d

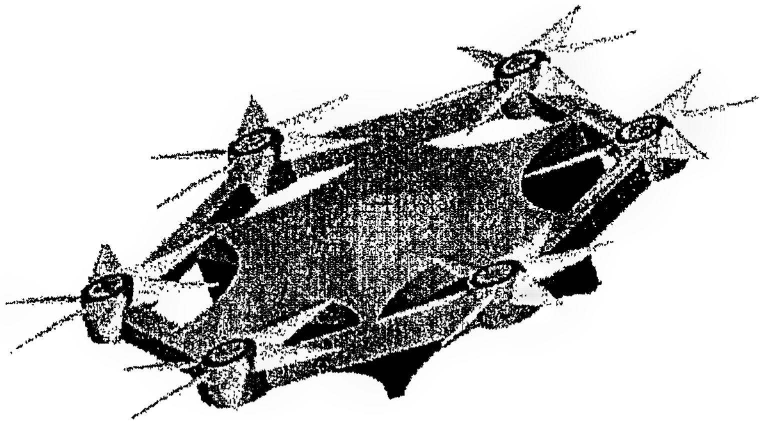


FIG. Q1e (Prior Art)

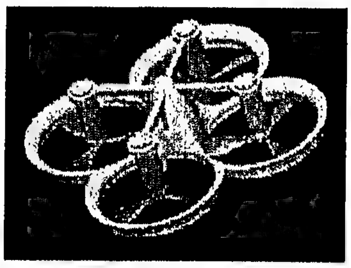
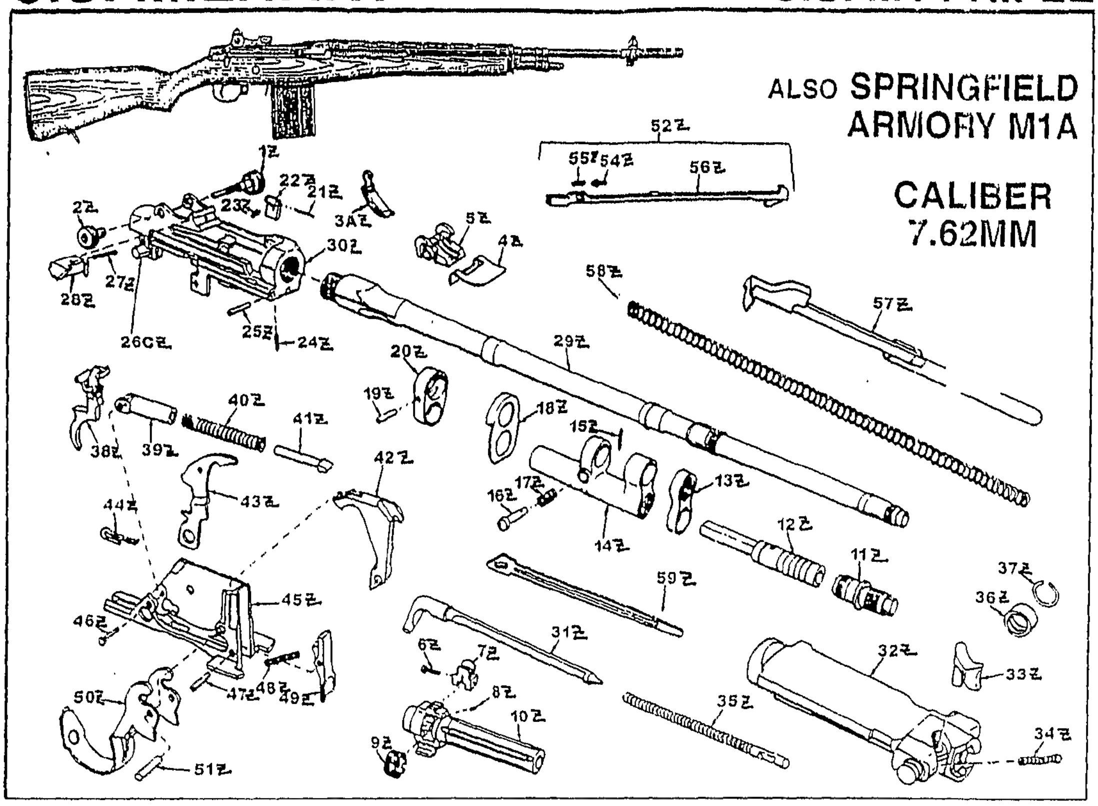


FIG. Q1f (Prior Art)

FIG. R1

U.S. MILITARY -PRIOR ART- U.S. M14 RIFLE

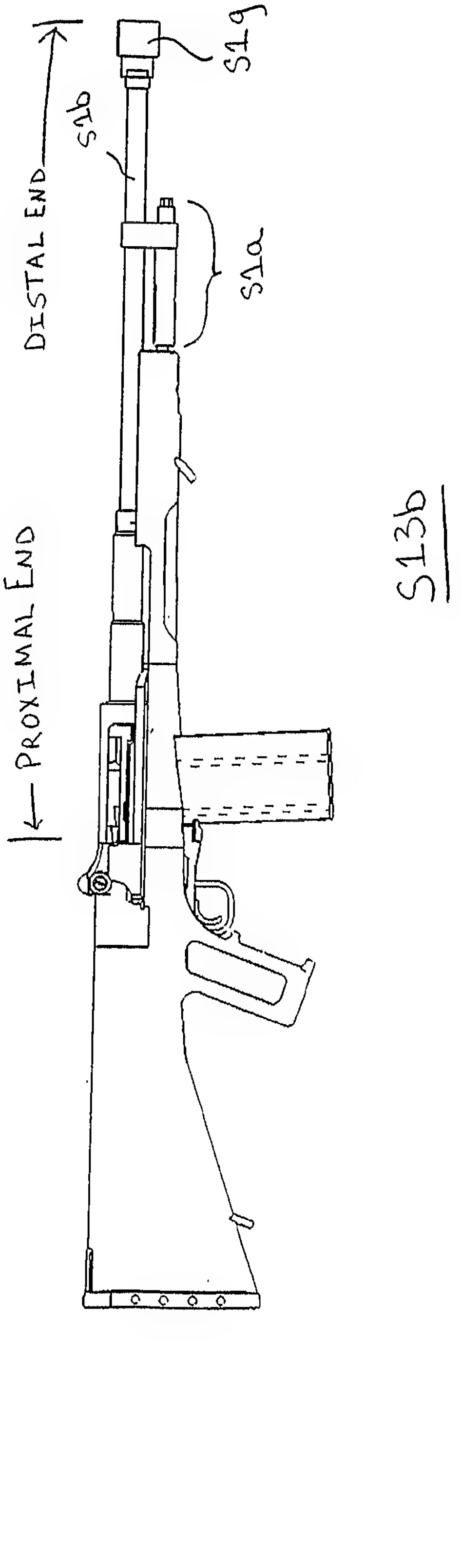


KEY #	DESCRIPTION
M14-1Z	Elevator Pinion (Rear Sight)
M14-2Z	Windage Knob
M14-3Z	Aperture
M14-4Z	Sight Cover
M14-5Z	Sight Base
M14-6Z	Front Sight Screw
M14-7Z	Front Sight
M14-8Z	Flash Suppressor Set Screw
M14-9Z	Flash Suppressor Nut.
M14-10Z	Flashhider/Flash Suppressor
M14-11Z	Gas Cylinder Plug
M14-12Z	Gas Piston
M14-13Z	Gas Cylinder Lock
M14-14Z	Gas Cylinder
M14-15Z	Pin (Gas Cylinder)
M14-16Z	Gas Cylinder Valve Spindle
M14-17Z	Gas Cylinder Valve Spring
M14-18Z	Front Band
M14-19Z	Operating Rod Guide Spring Pin
M14-20Z	Operating Rod Guide
M14-21Z	Pin (Bolt Lock)
M14-22Z	Bolt Lock
M14-23Z	Bolt Lock Spring.
M14-24Z	Pin (Connector Lock)
M14-25Z	Connector Lock
M14-26AZ	Selector Pin, NI
M14-26BZ	Selector Shaft Lock, NI
M14-26CZ	Selector
M14-26DZ	Selector Spring, NI

KEY #	DESCRIPTION
M14-26EZ	Selector Shaft, NI
M14-26FZ	Sear Release, NI
M14-27Z	Clip Guide Pin . .
M14-28Z	Cartridge Clip Guide.
M14-29Z	Barrel
M14-30Z	Receiver, National Match Semi-Auto, (FFL Req'd)
M14-31Z	Firing Pin
M14-32Z	Bolt, Stripped, GI
M14-32AZ	Bolt Assembly, NI
M14-33Z	Extractor
M14-34Z	Extractor Plunger And Spring
M14-35Z	Ejector And Spring
M14-36Z	Bolt Roller
M14-37Z	Bolt Roller Retainer
M14-38Z	Trigger And Sear Assembly
M14-38AZ	Sear, NI
M14-39Z	Hammer Spring Housing
M14-40Z	Hammer Spring
M14-41Z	Hammer Plunger
M14-42Z	Hammer
M14-43Z	Safety
M14-44Z	Safety Spring
M14-45Z	Trigger Housing, Stripped
M14-45AZ	Trigger Housing, Complete, NI
M14-46Z	Trigger Pin
M14-47Z	Magazine Latch Pin
M14-48Z	Magazine Latch Spring
M14-49Z	Magazine Latch

KEY #	DESCRIPTION
M14-50Z	Trigger Guard
M14-51Z	Trigger Guard Pin
M14-52Z	Connector Rod Assembly
M14-53Z	Connector Rod Pin, NI
M14-54Z	Connector Spring
M14-55Z	Connector Plunger
M14-56Z	Connector Rod Body, Stripped
M14-57Z	Operating Rod
M14-58Z	Operating Rod Spring
M14-59Z	Operating Rod Spring Guide
M14-60Z	Buttplate Assembly, NI
M14-61Z	Butt Screw, Short, NI
M14-62Z	Butt Screw, Long, NI
M14-63Z	Butt Screw For Plastic Stock (Incl Screw, Nut & Washer), NI
M14-64Z	Rear Swivel, NI
M14-65Z	Stock Liner Screw (2 Req'd) .
M14-66Z	Stock Liner, NI
M14-67AZ	Handguard, Fiberglass, New, NI
M14-67BZ	Handguard, Fiberglass, Used, NI
M14-68Z	
869Z	Blank Attachment (Issue) & Breech Cover, NI
M14-71Z	Flash Suppressor Wrench, NI
M14-72Z	Magazine, 308 Cal , 20 Round, NI
M14-73Z	Ammo Belt (Holds 12 M14 Mags)

FIG. S1



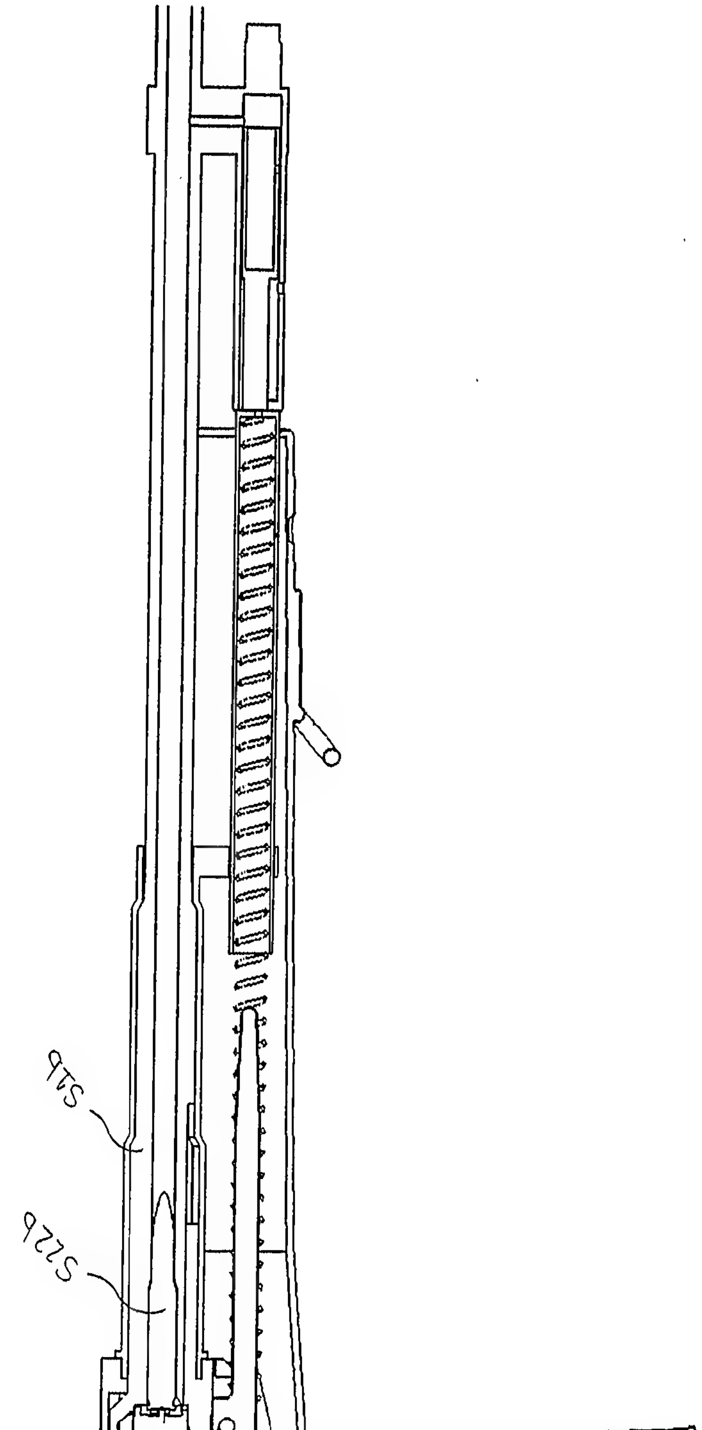


FIG. S2

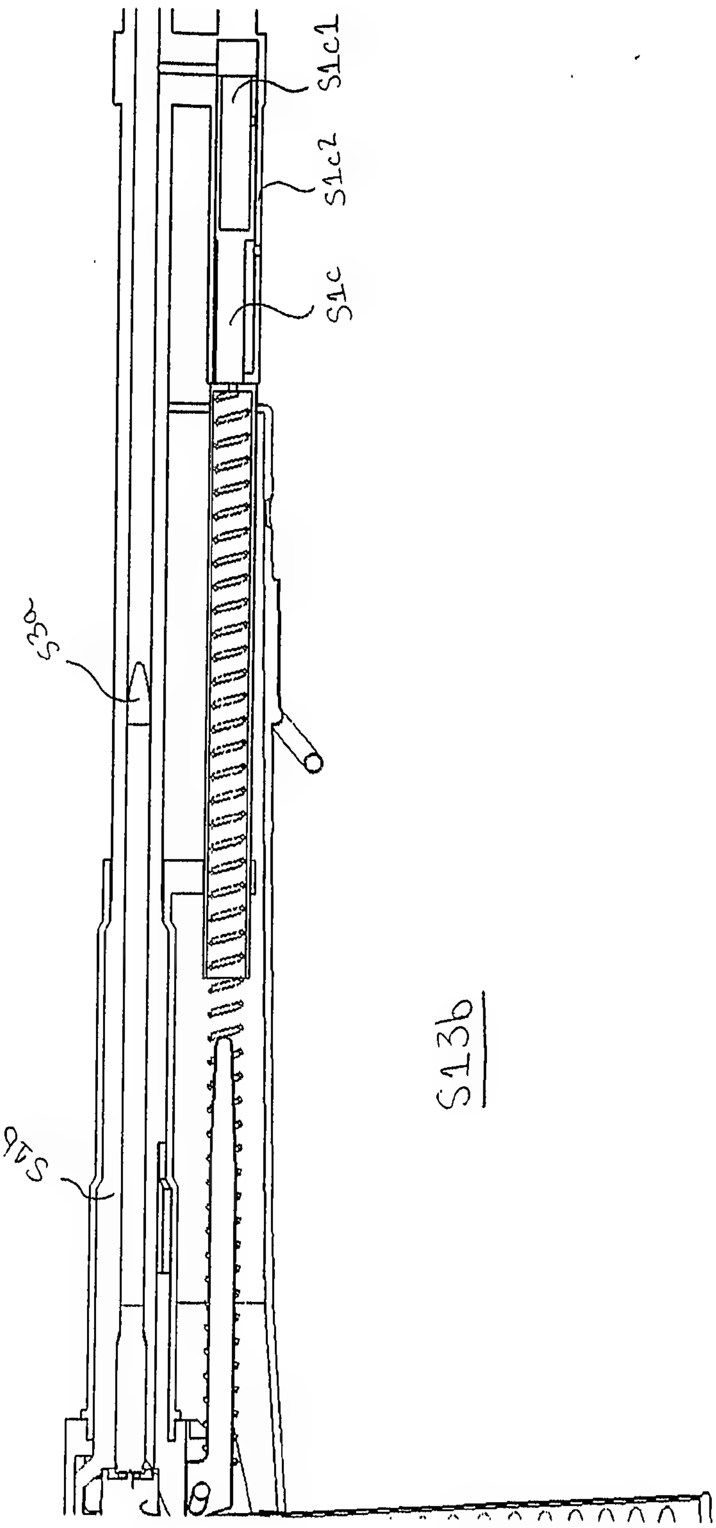


FIG. S3

FIG. S4

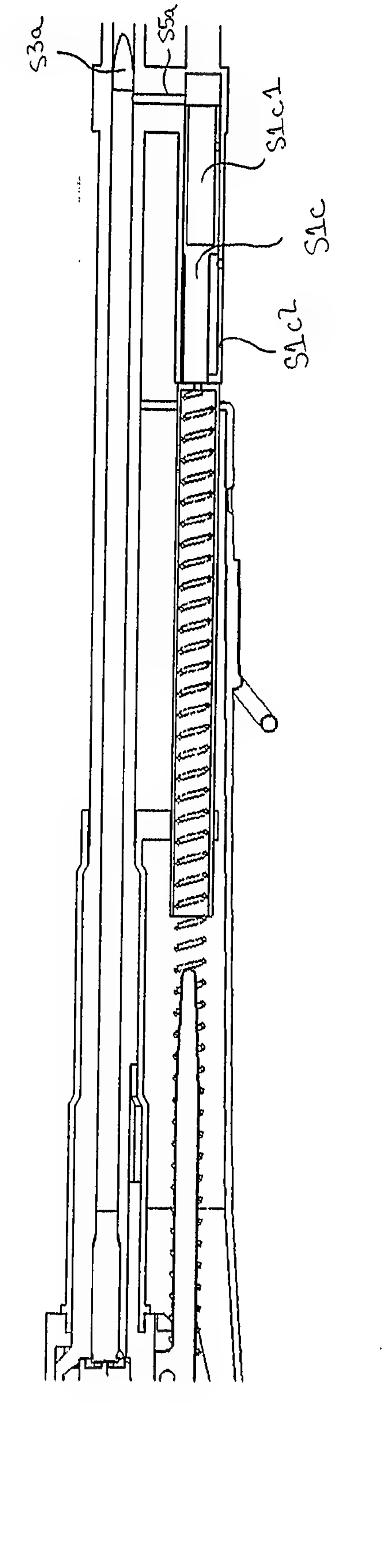
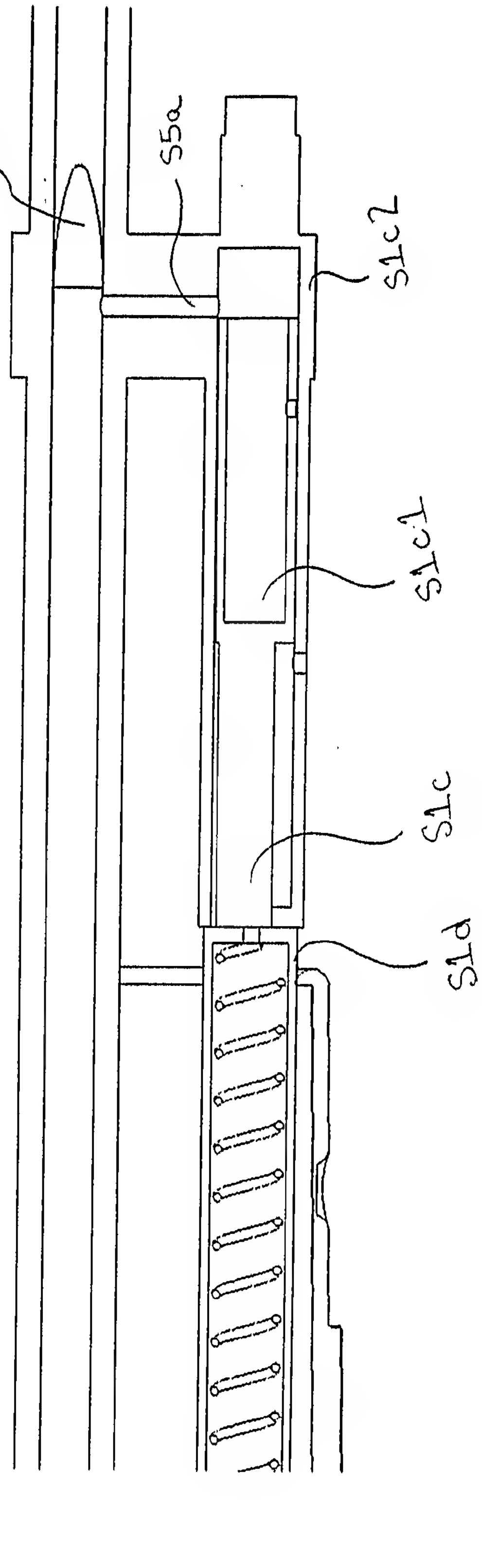


FIG. S5



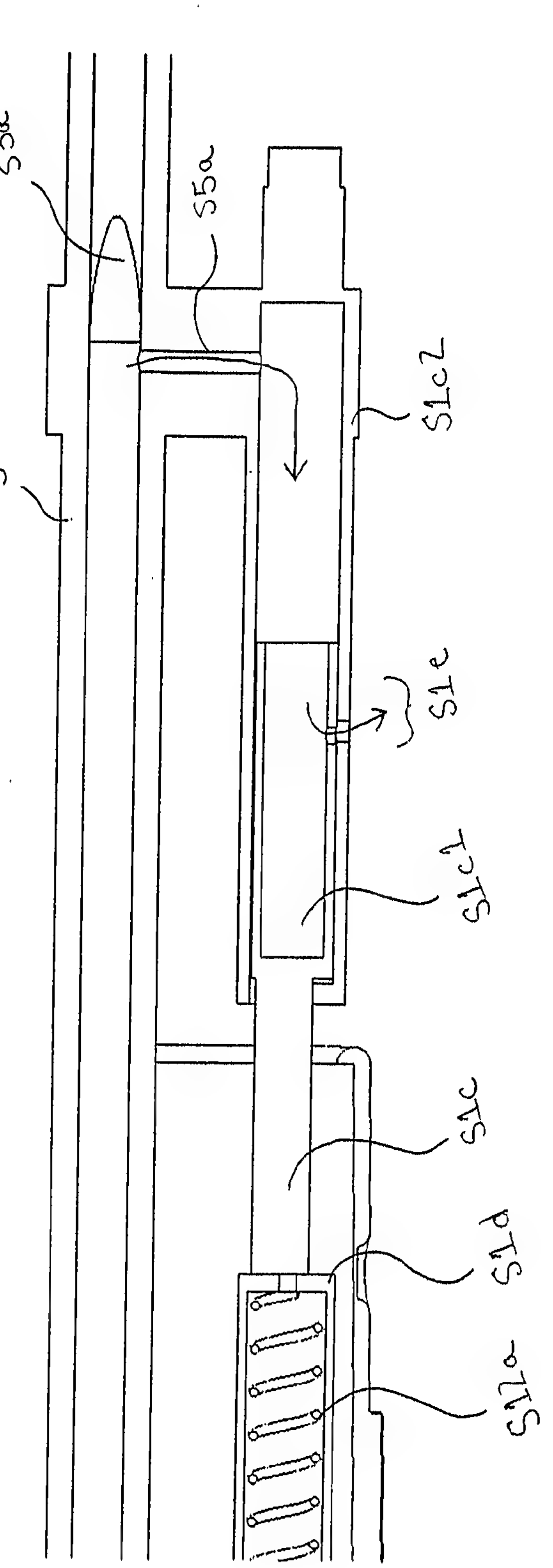


FIG. S6

FIG. S7

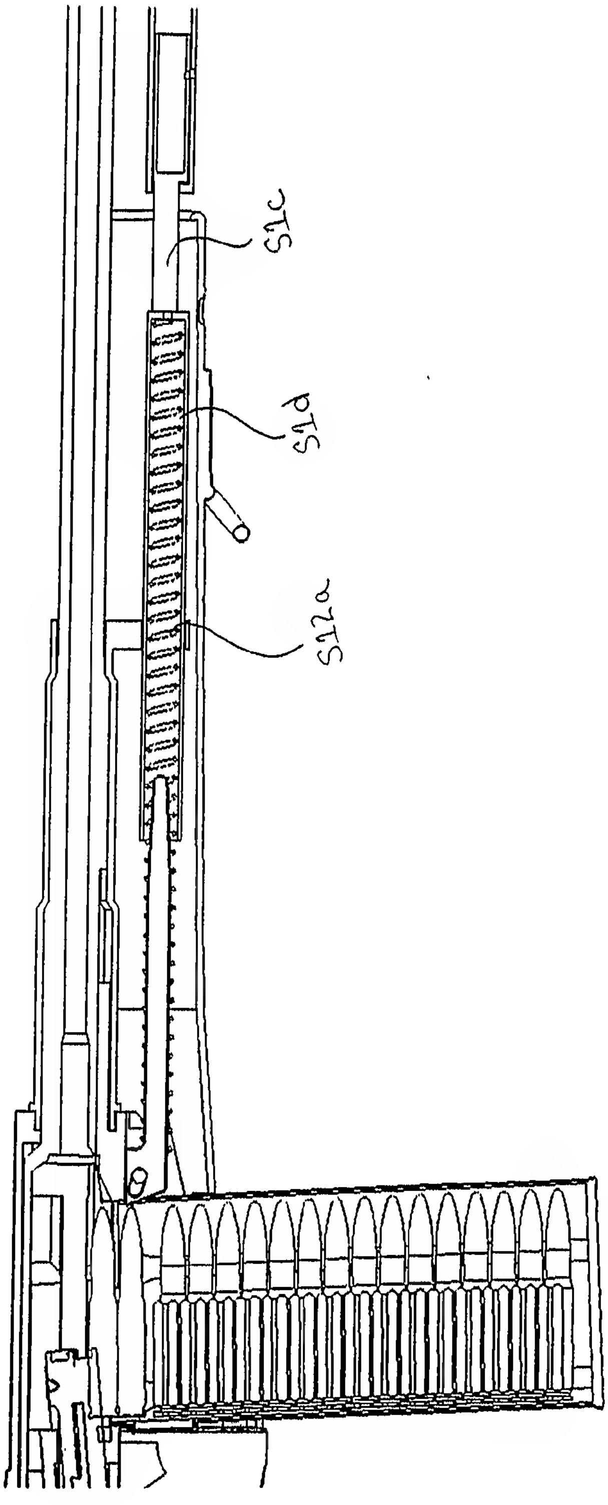


FIG. S8

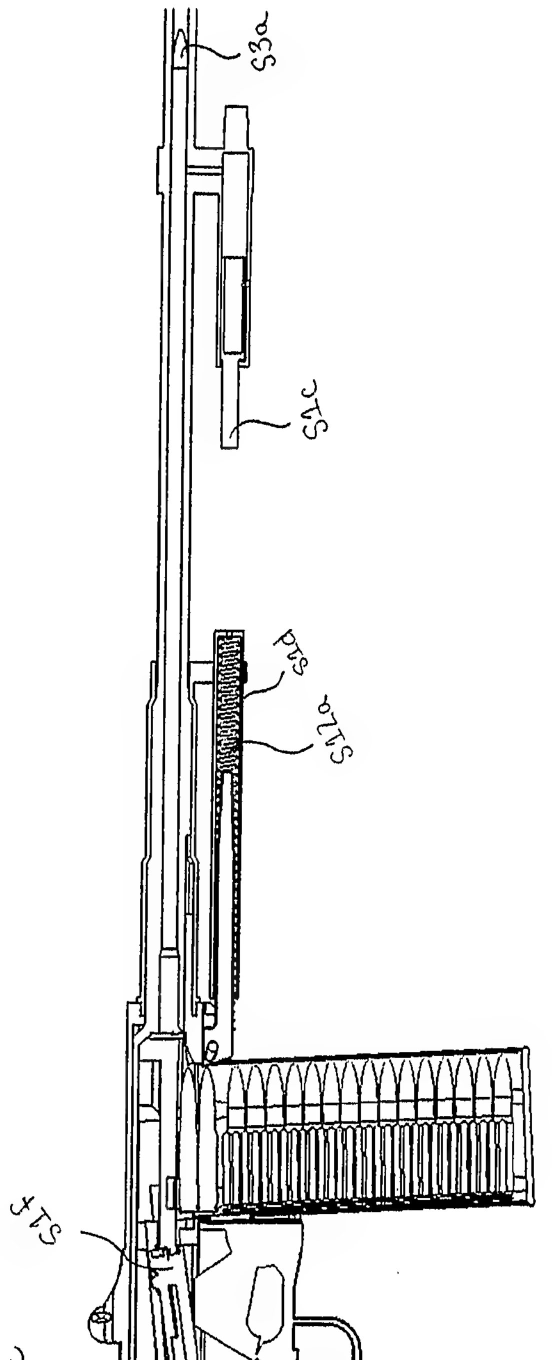
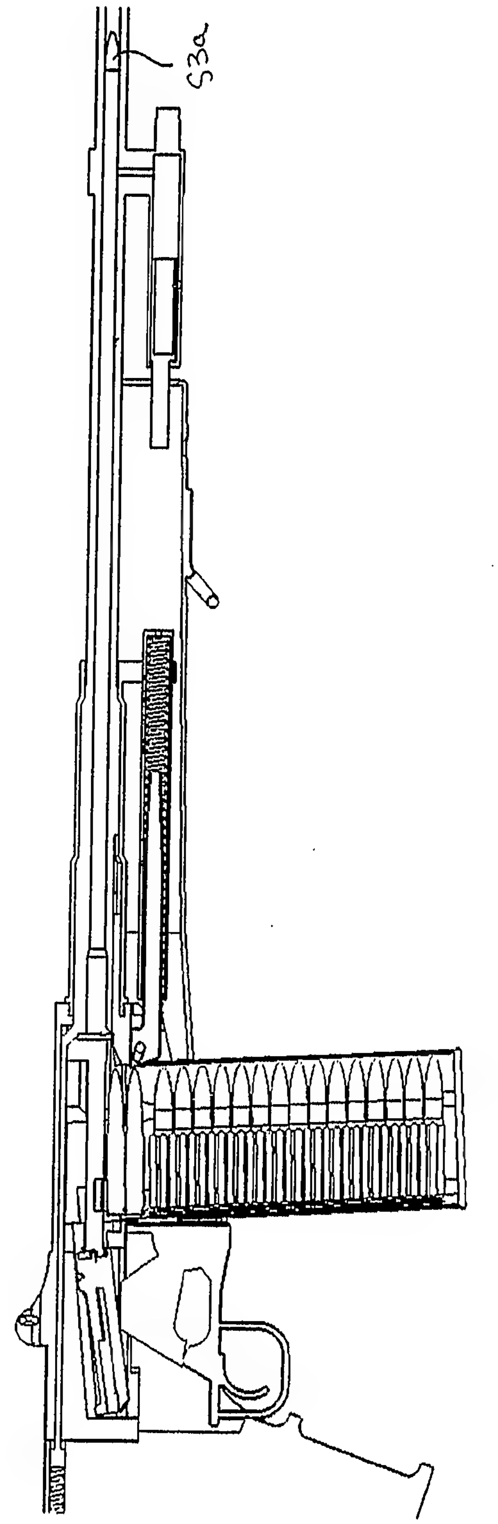


FIG. S9



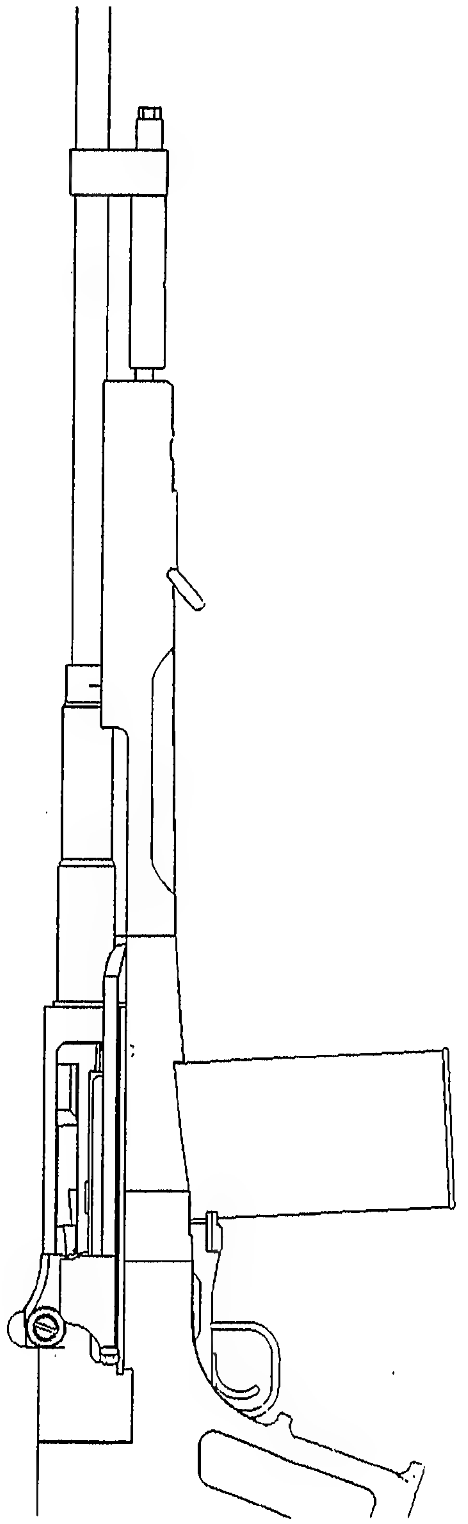
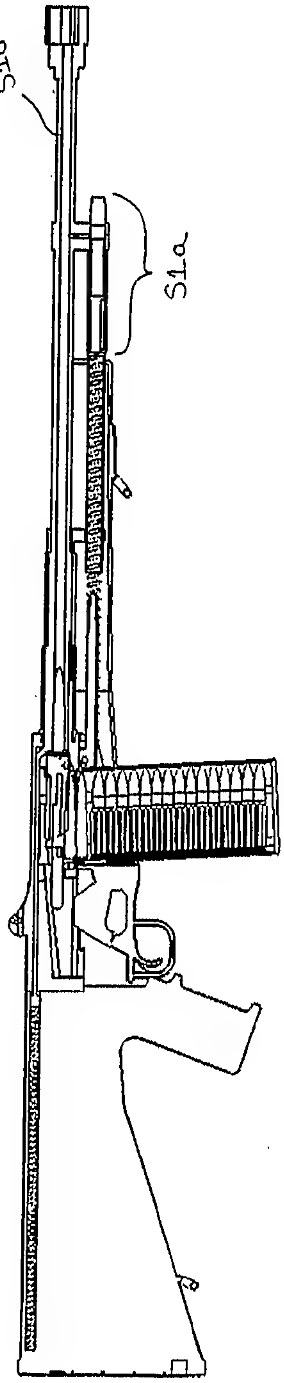


FIG. S10

FIG. S11



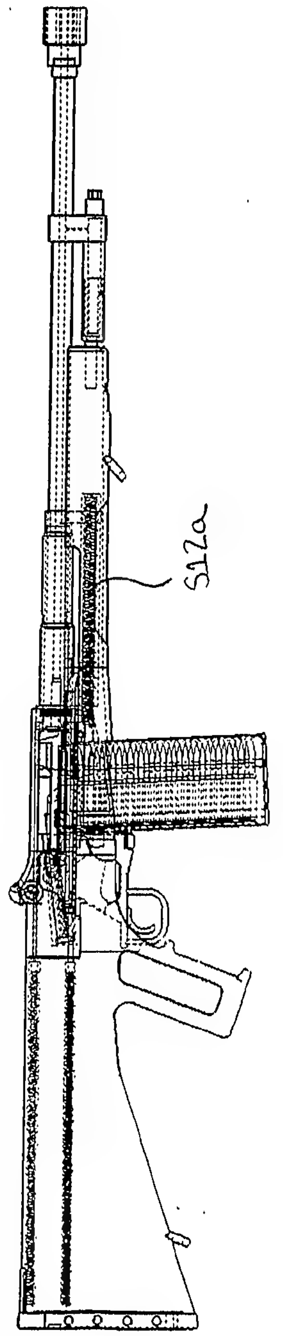


FIG. S12

FIG. S13

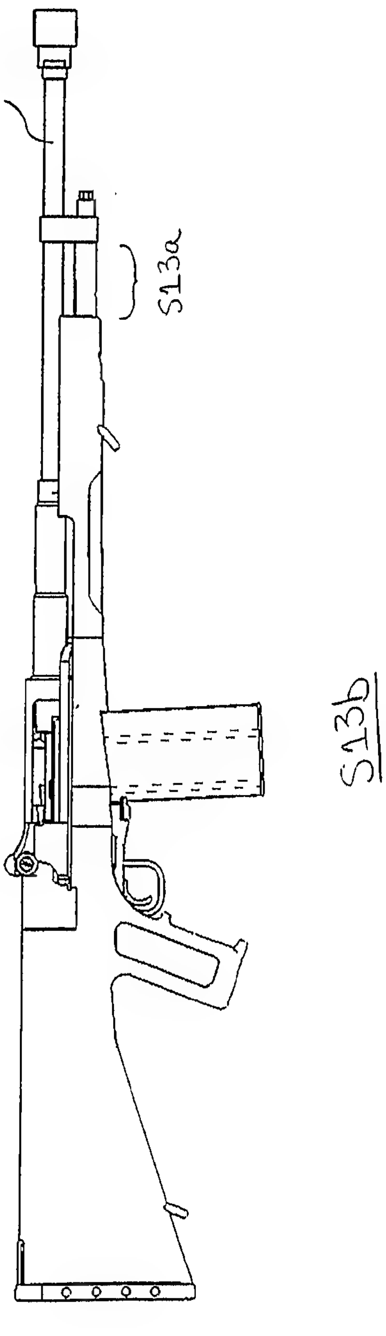
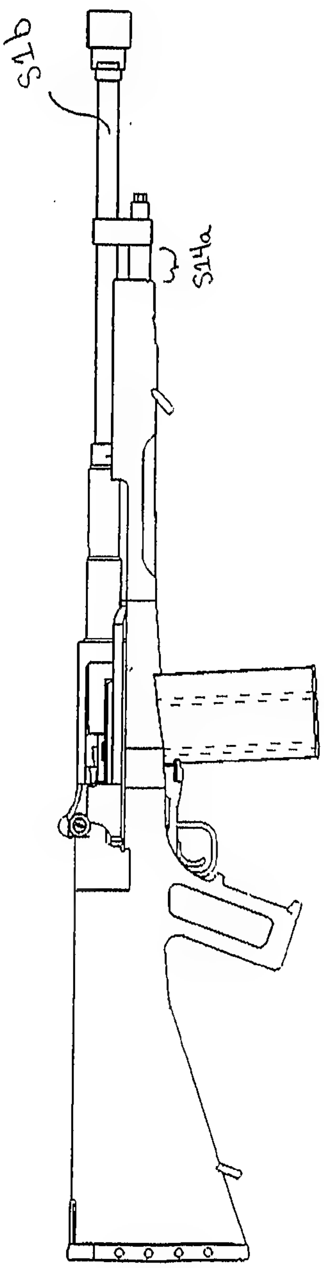
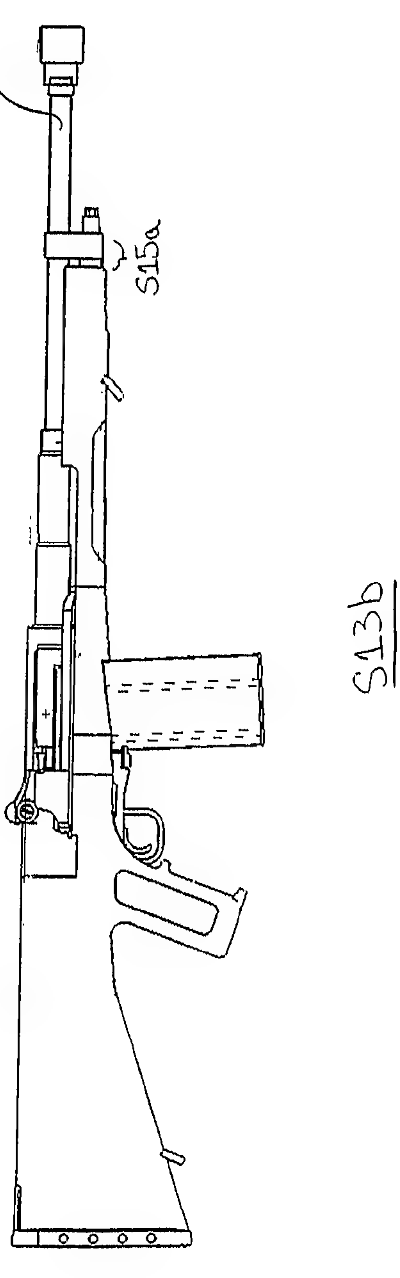


FIG. S14



S13b

FIG. S15



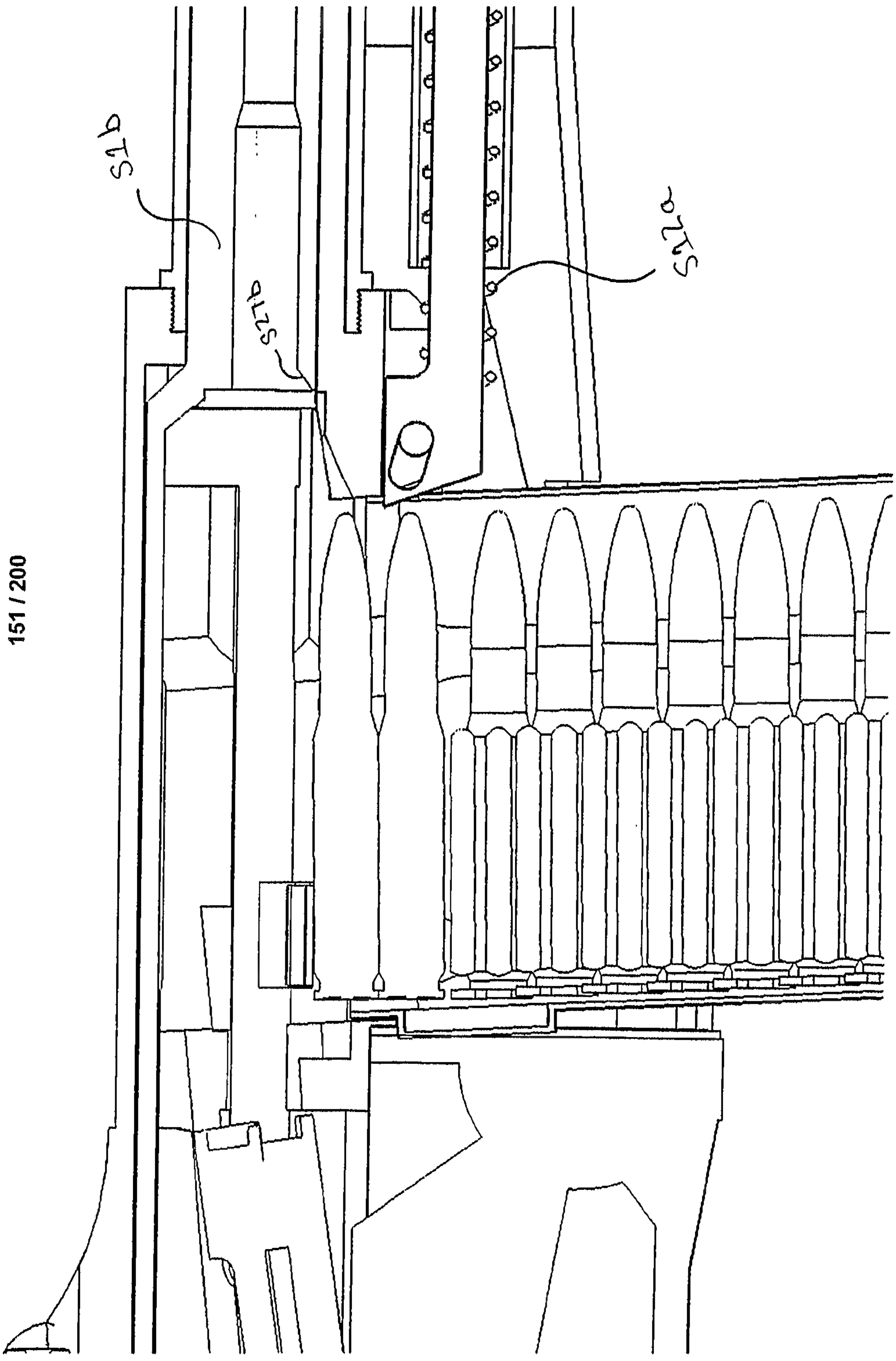
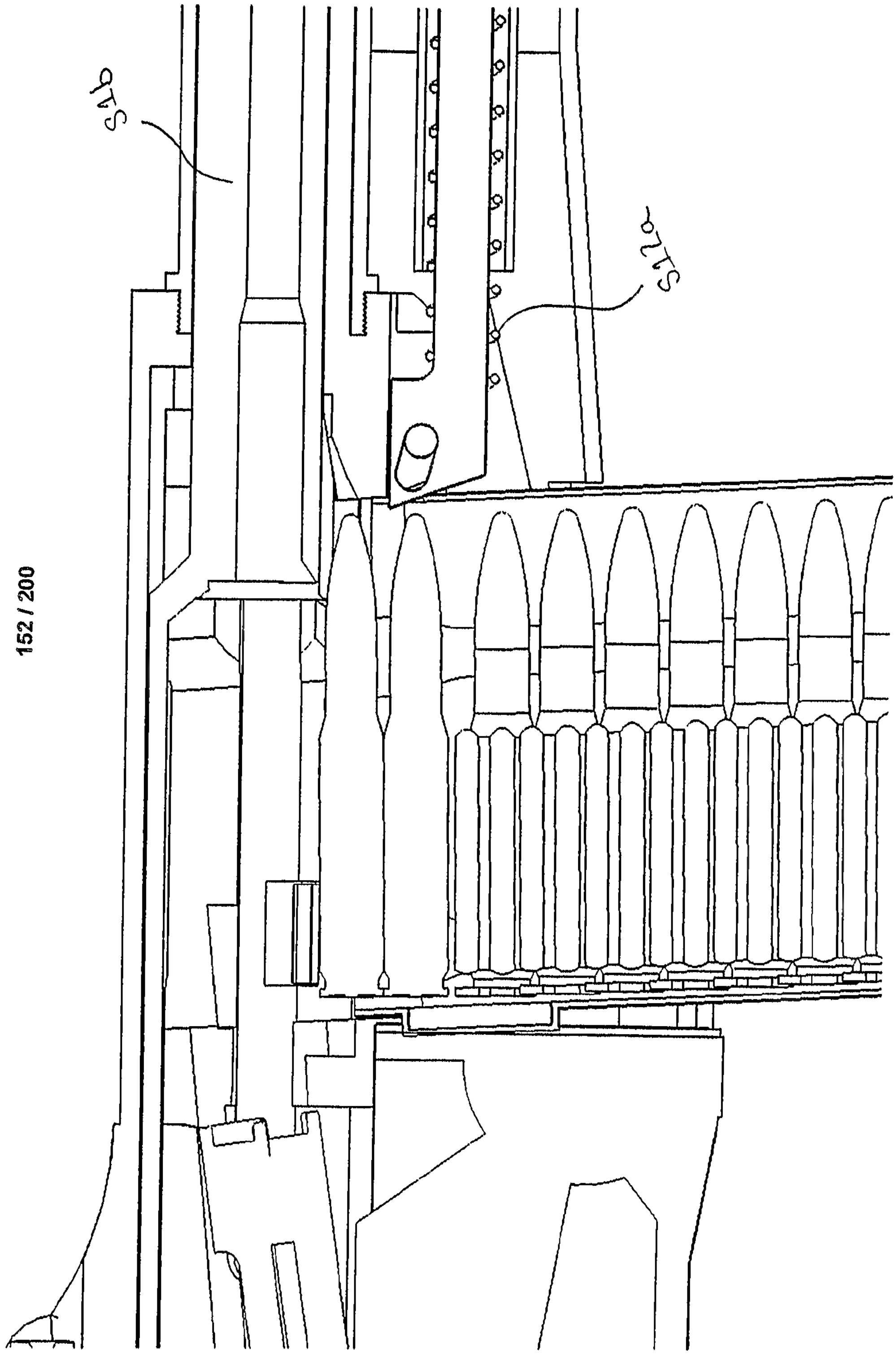


FIG. S16

FIG. S17



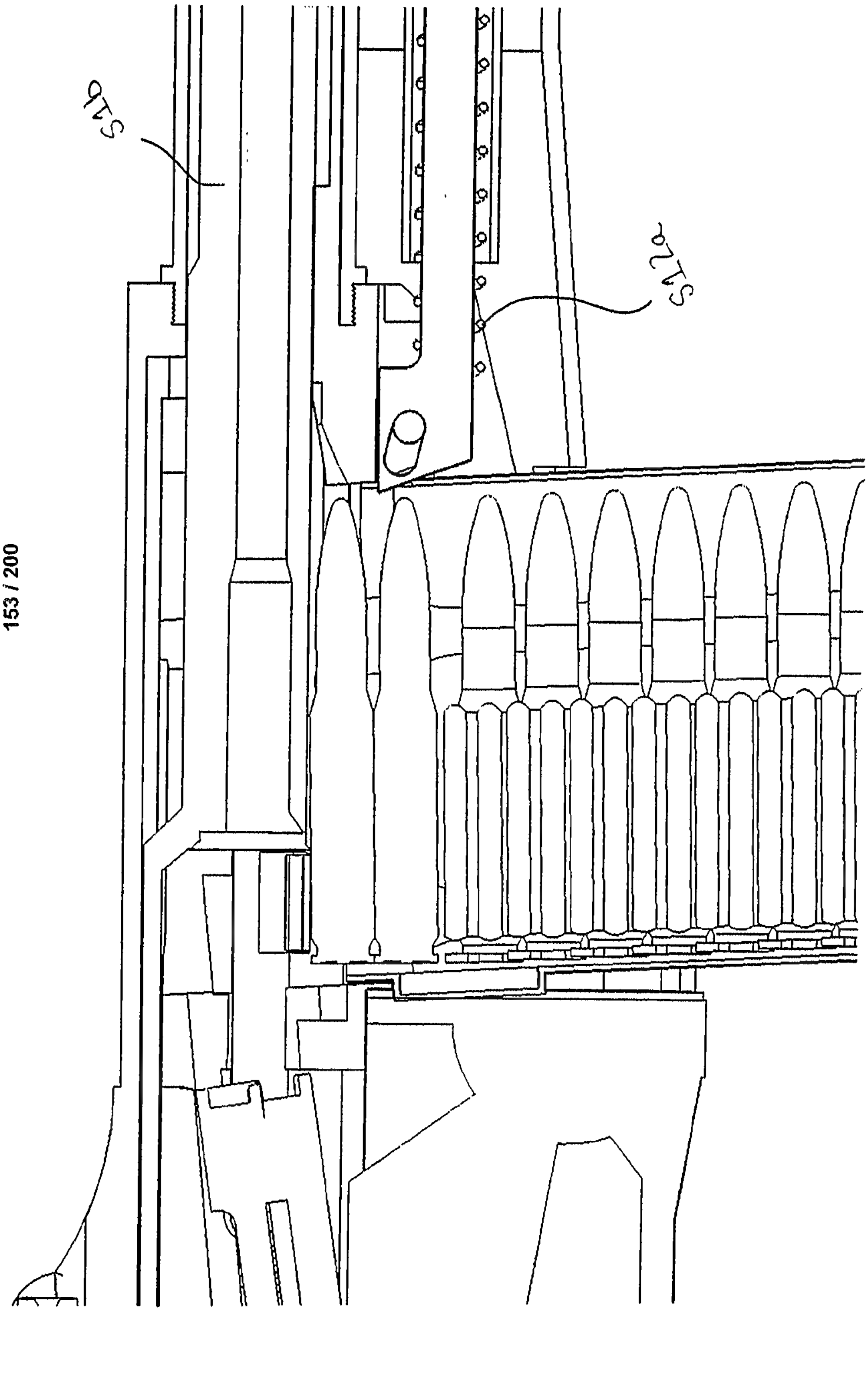
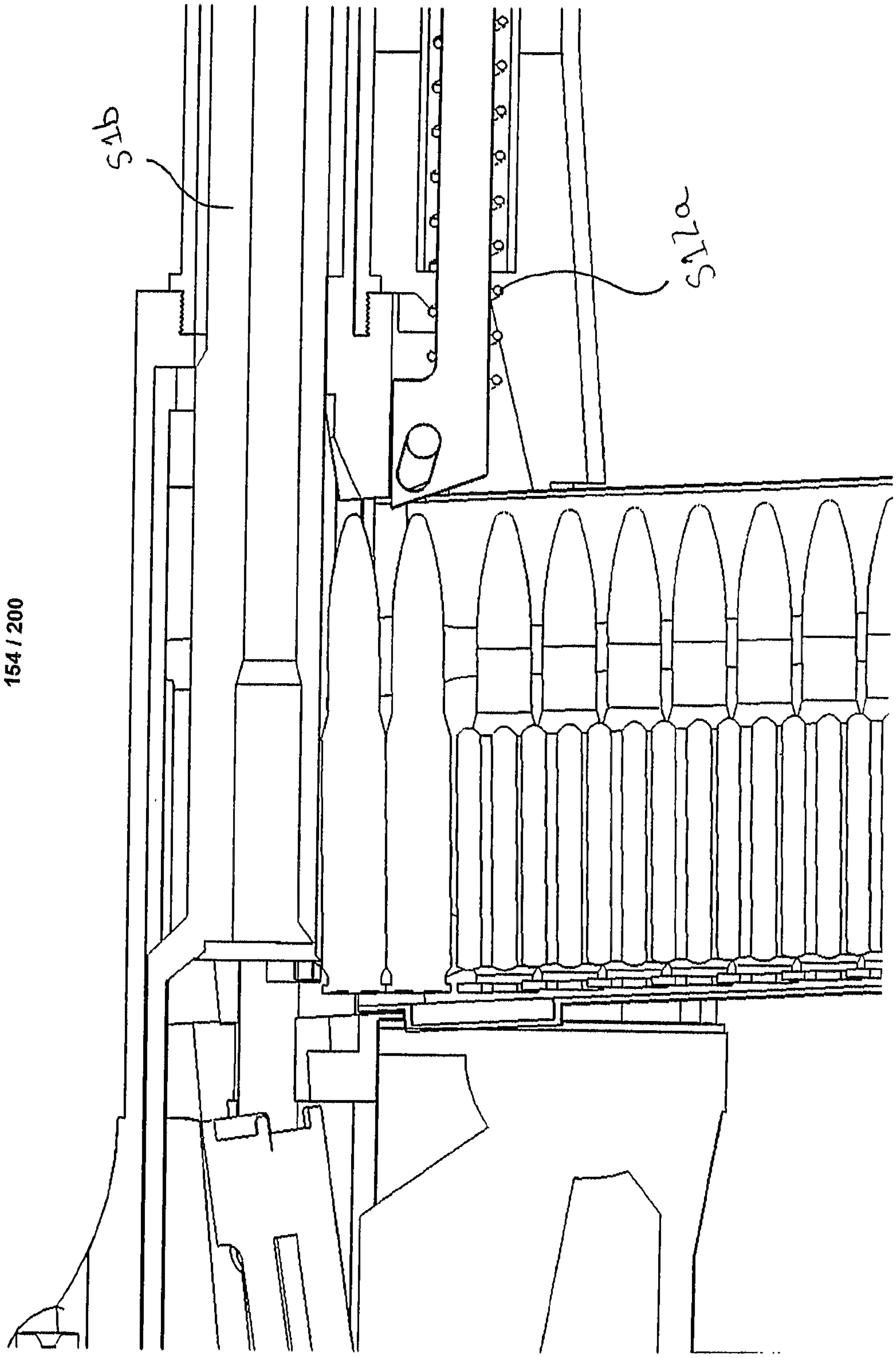


FIG. S18

FIG. S19



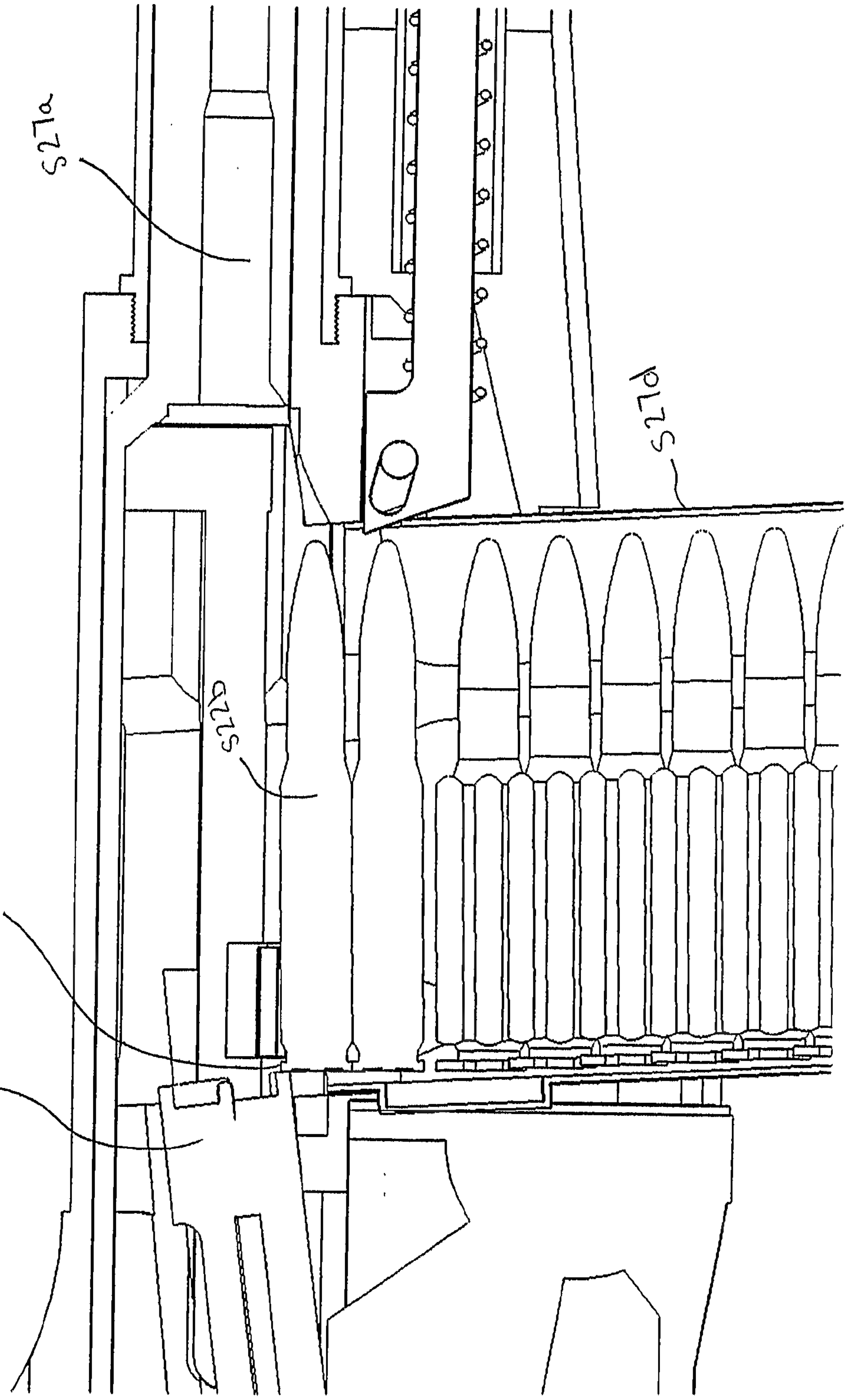


FIG. S20

FIG. S21

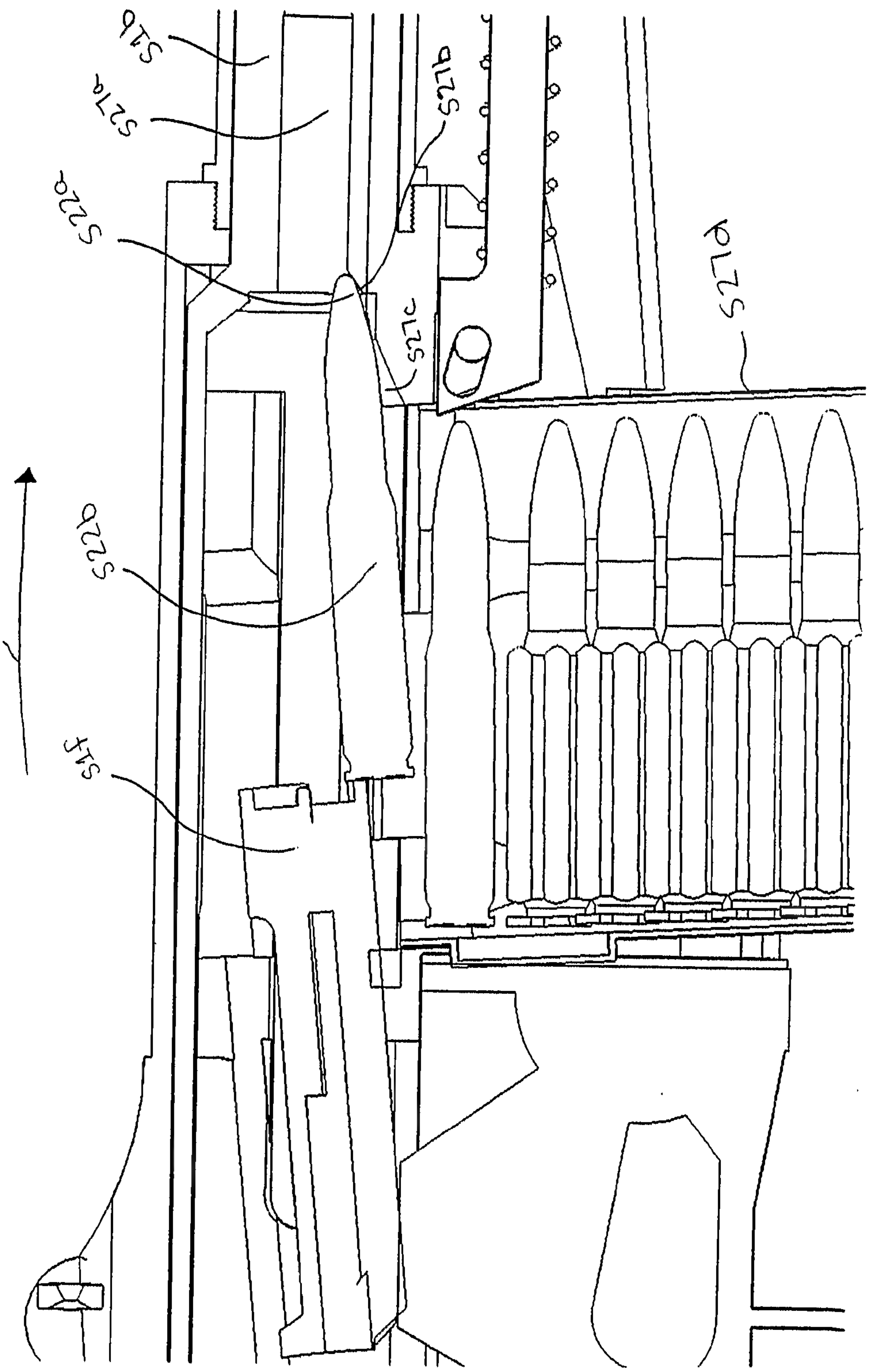


FIG. S22

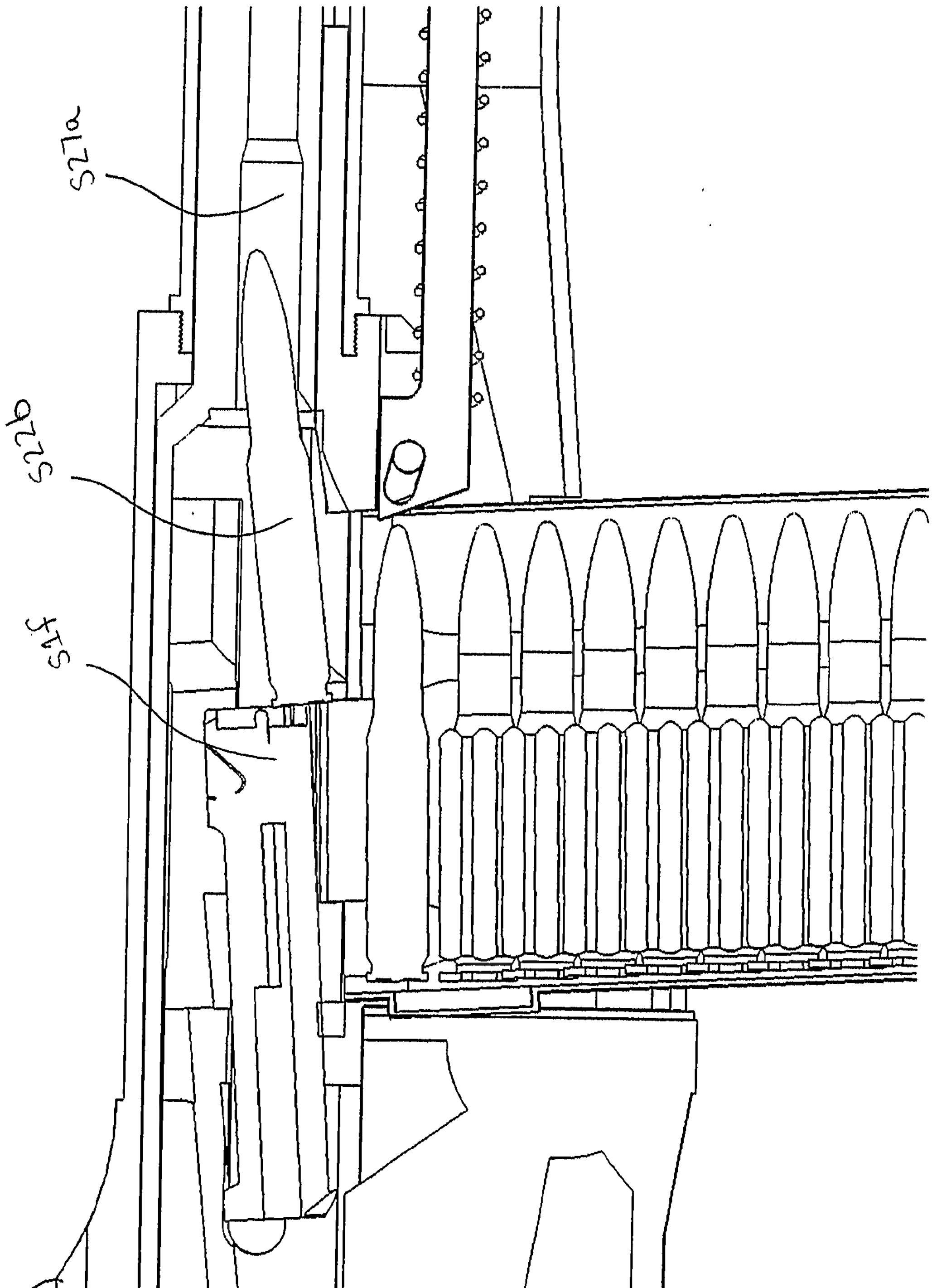


FIG. S23

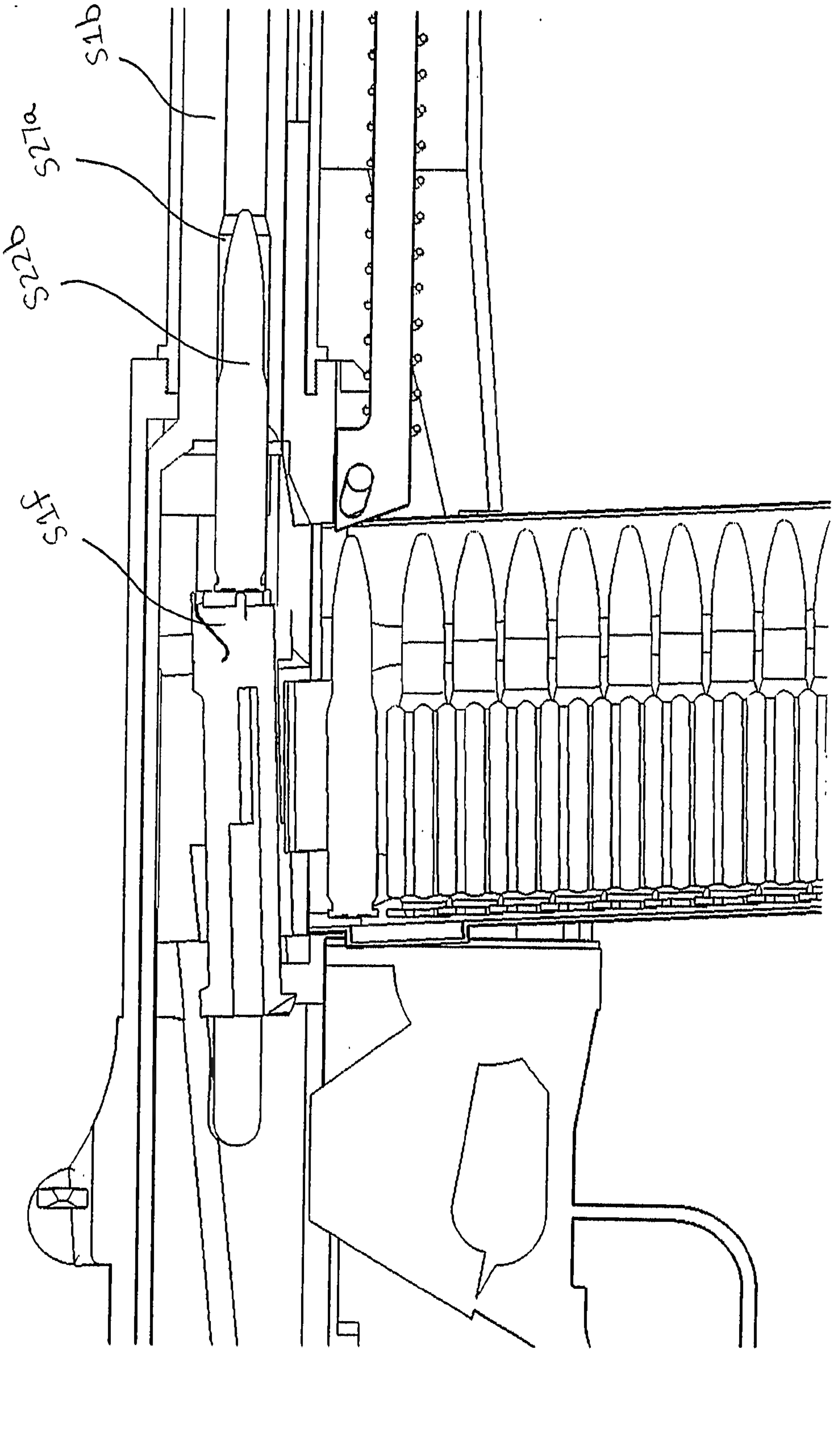


FIG. S24

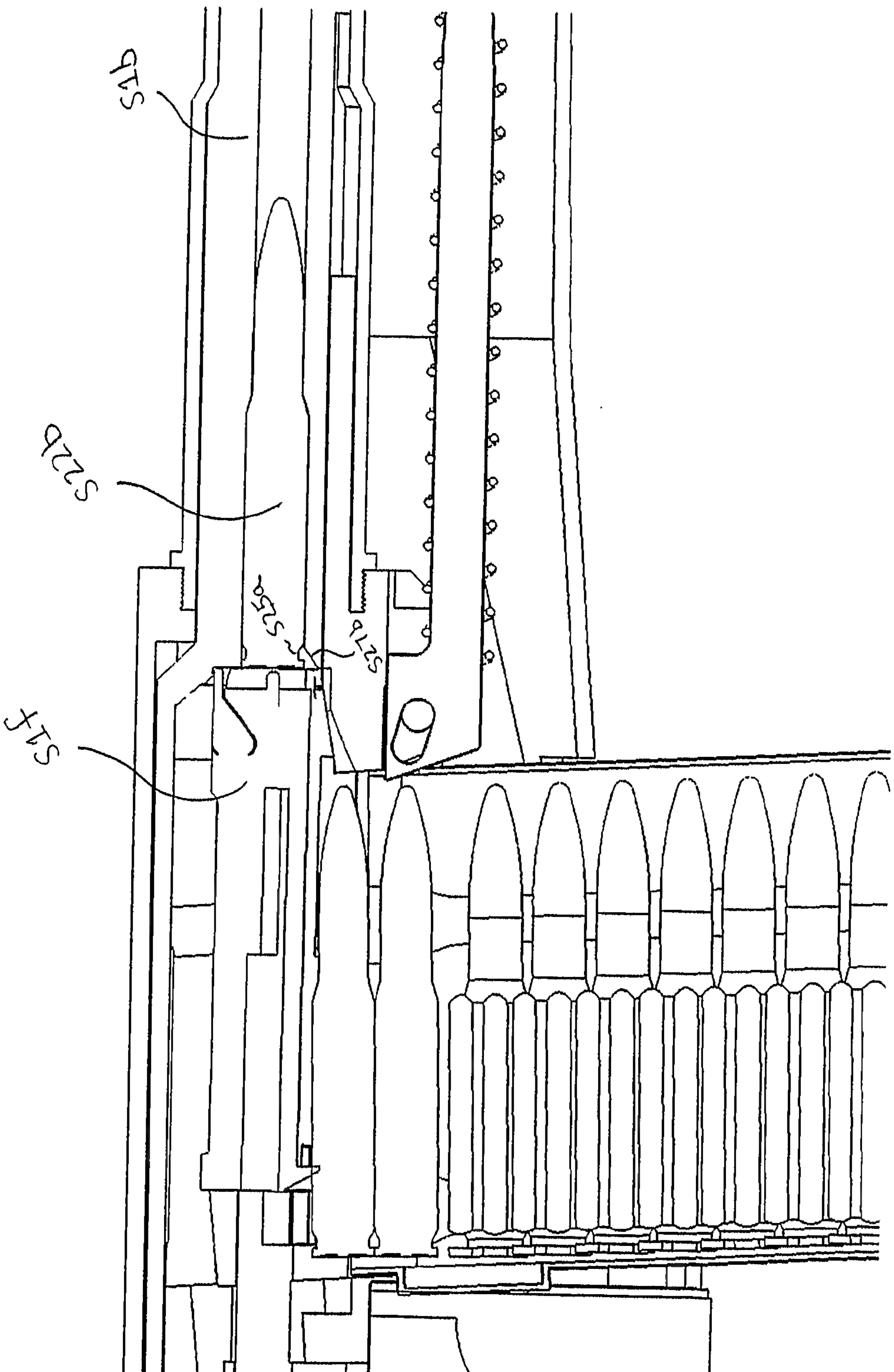


FIG. S25

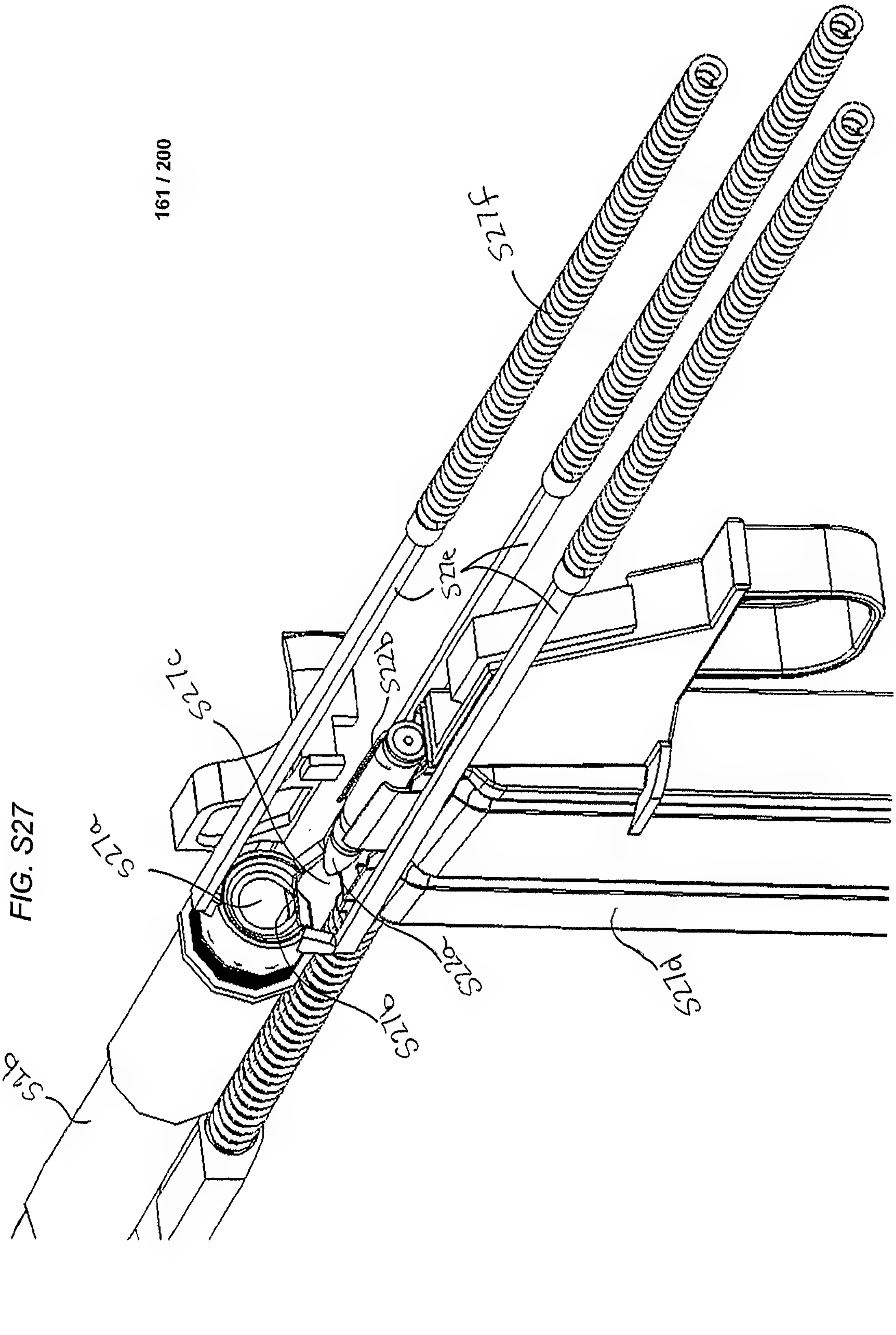


FIG. S27

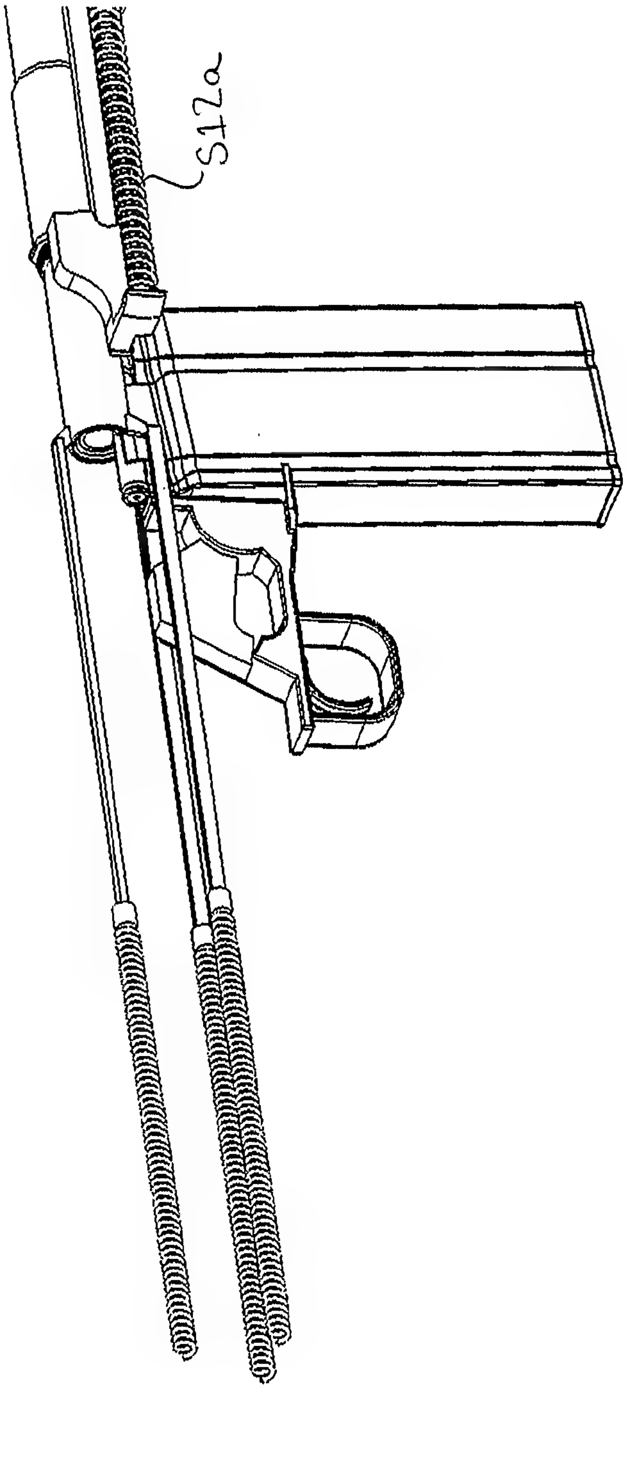


FIG. S28

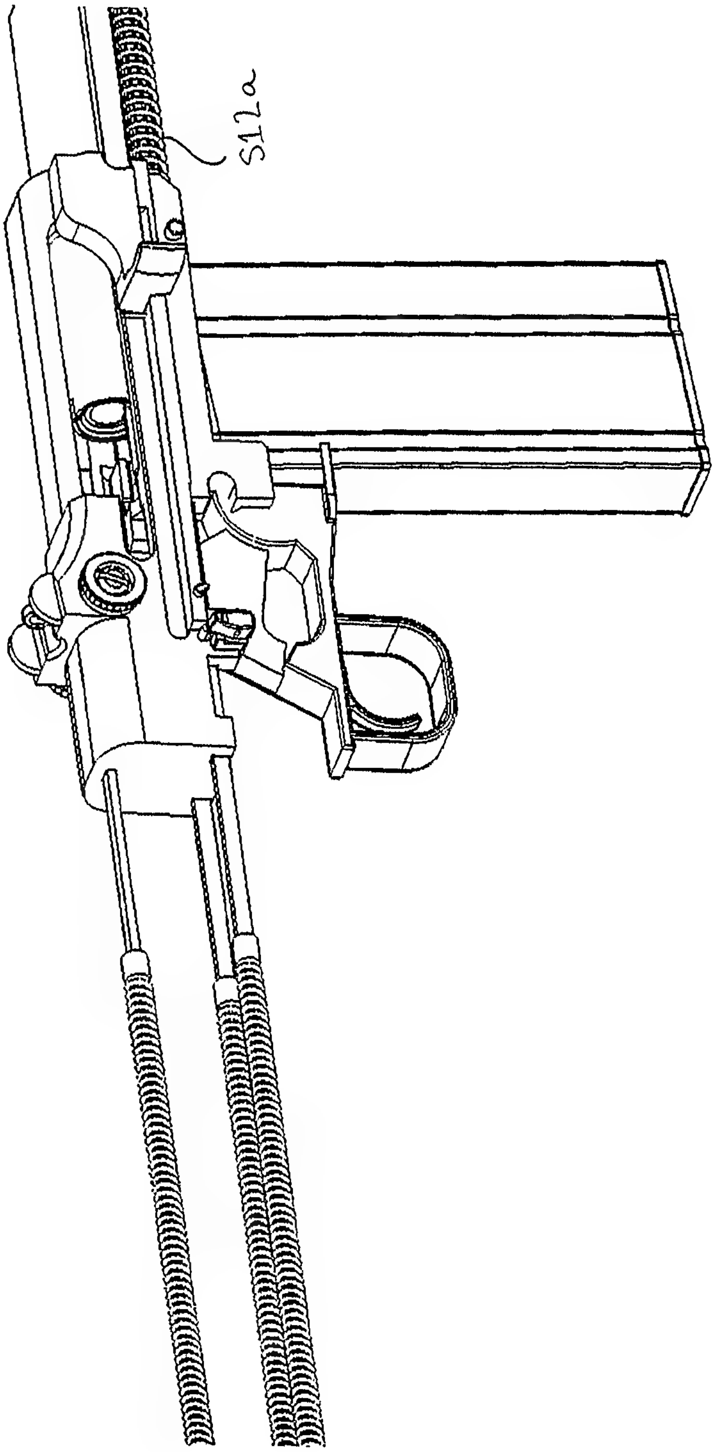


FIG. S29

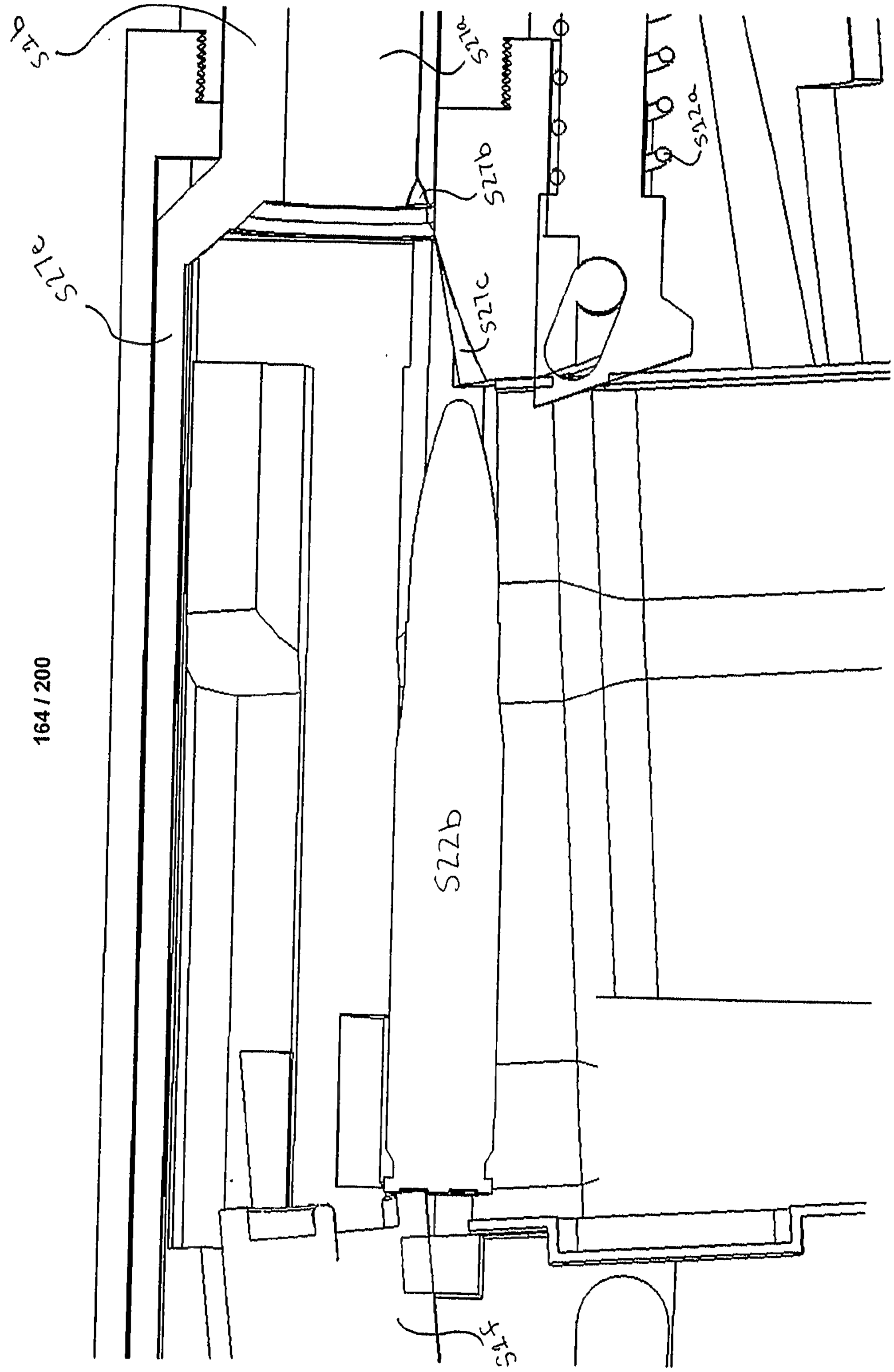


FIG. S30

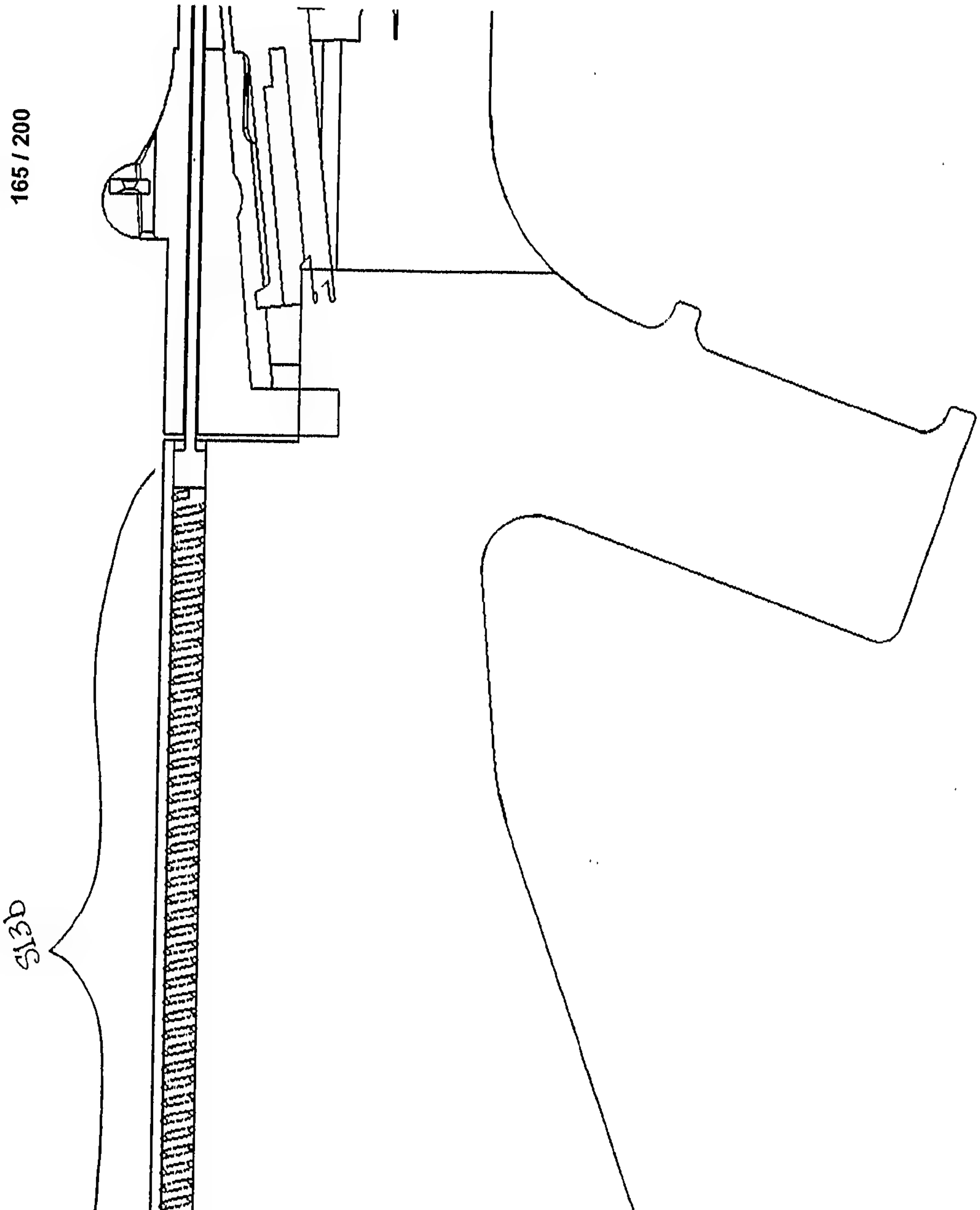


FIG. S31

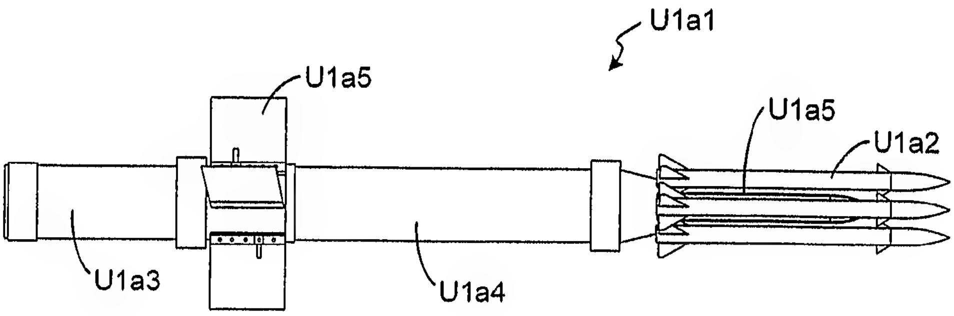


FIG. U1a

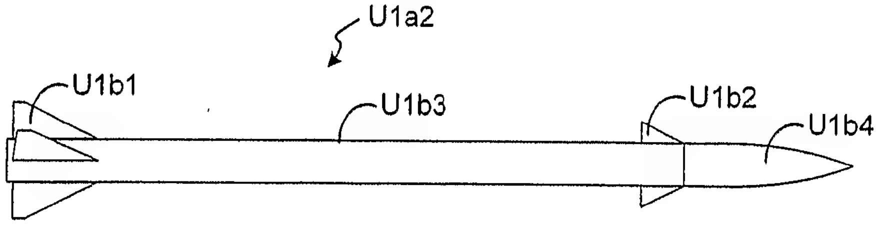


FIG. U1b

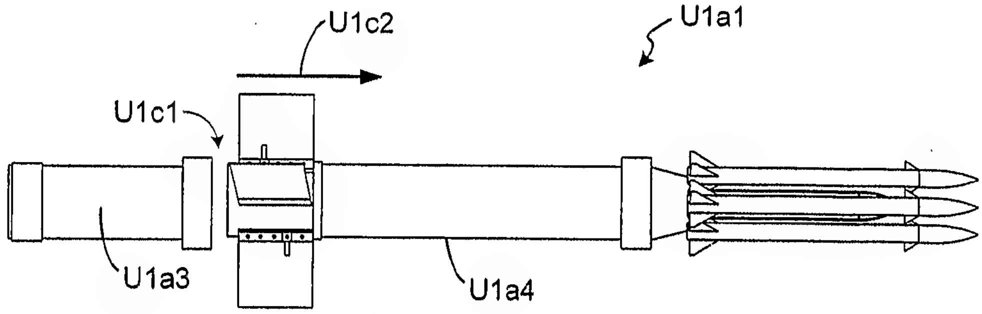


FIG. U1c

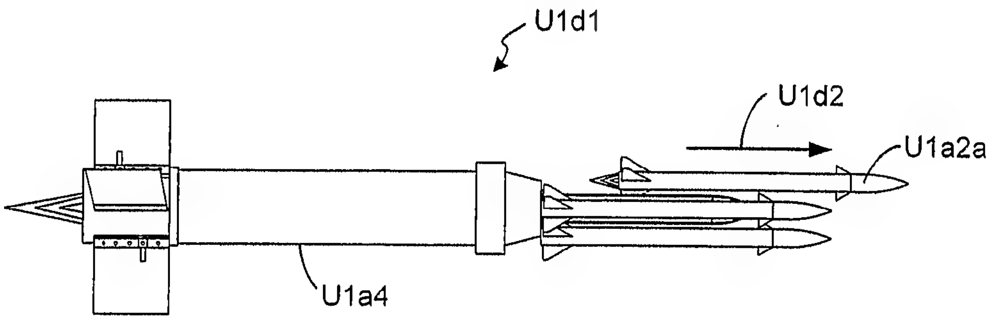


FIG. U1d

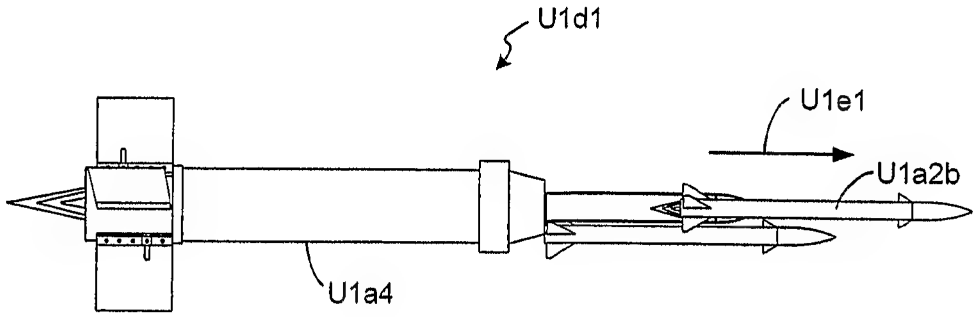


FIG. U1e

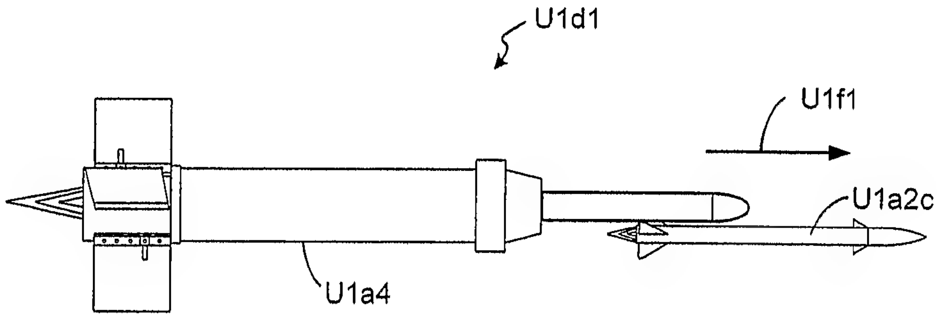


FIG. U1f

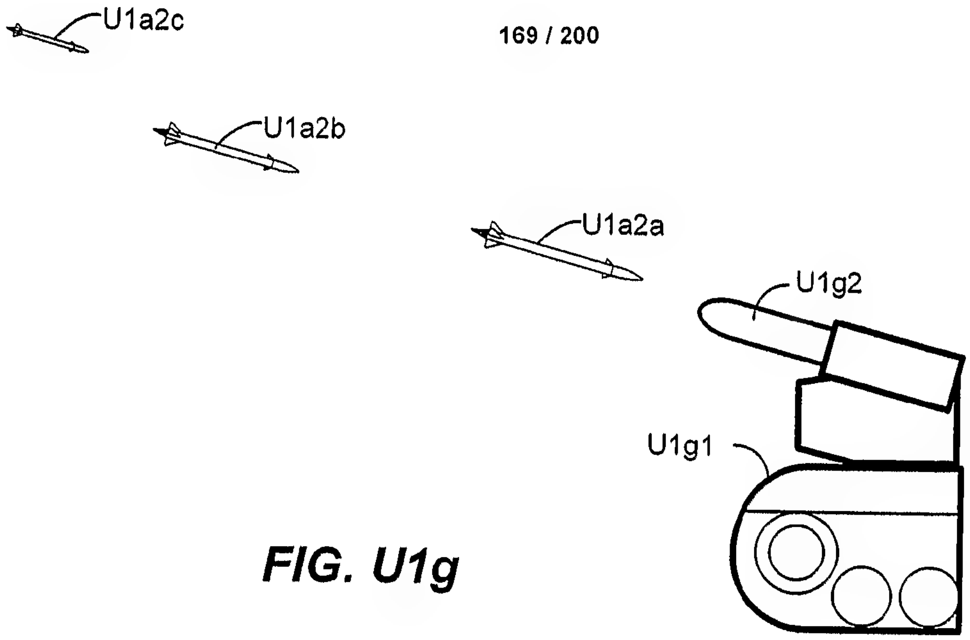


FIG. U1g

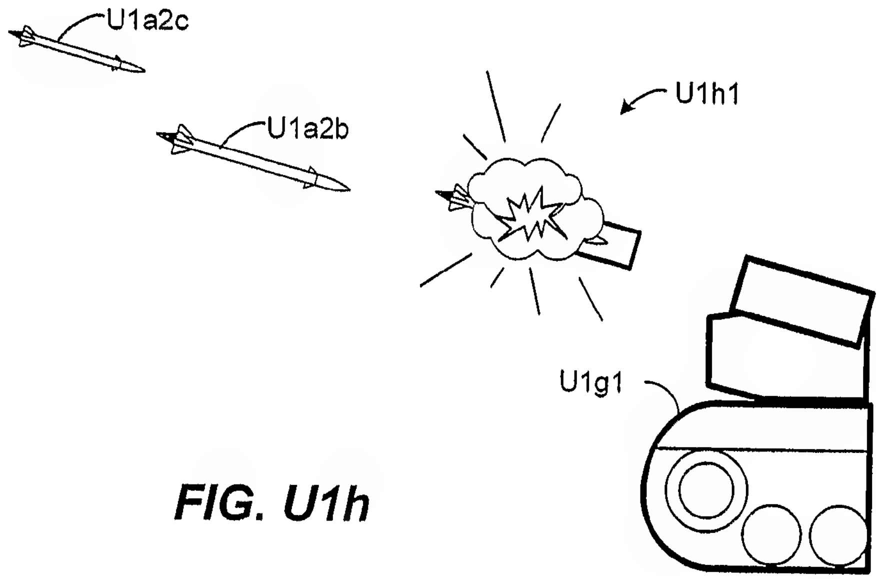


FIG. U1h

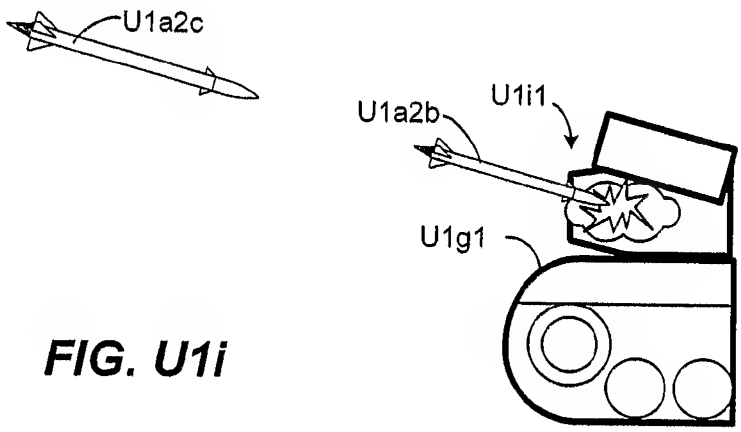


FIG. U1i

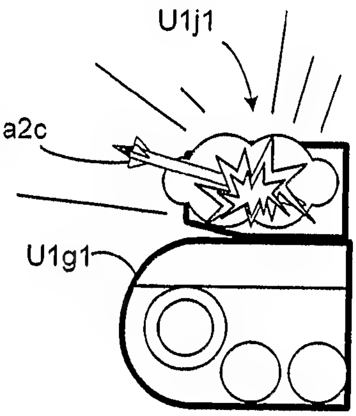


FIG. U1j

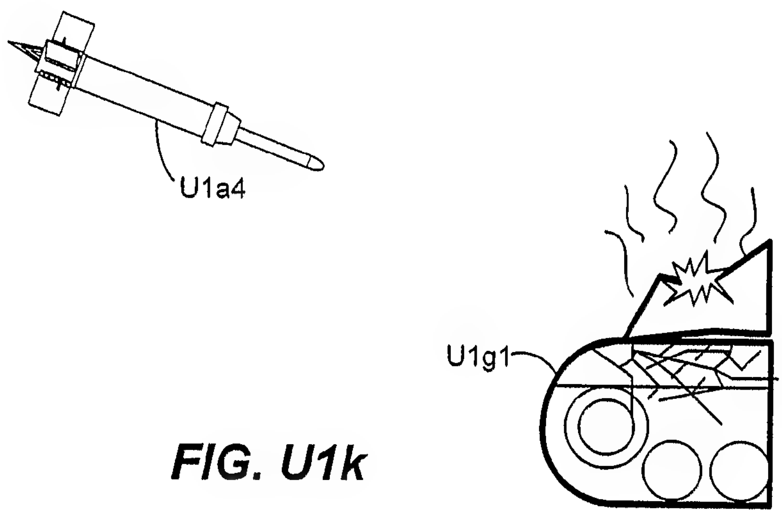


FIG. U1k

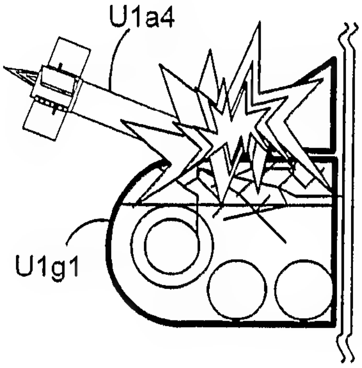


FIG. U1l

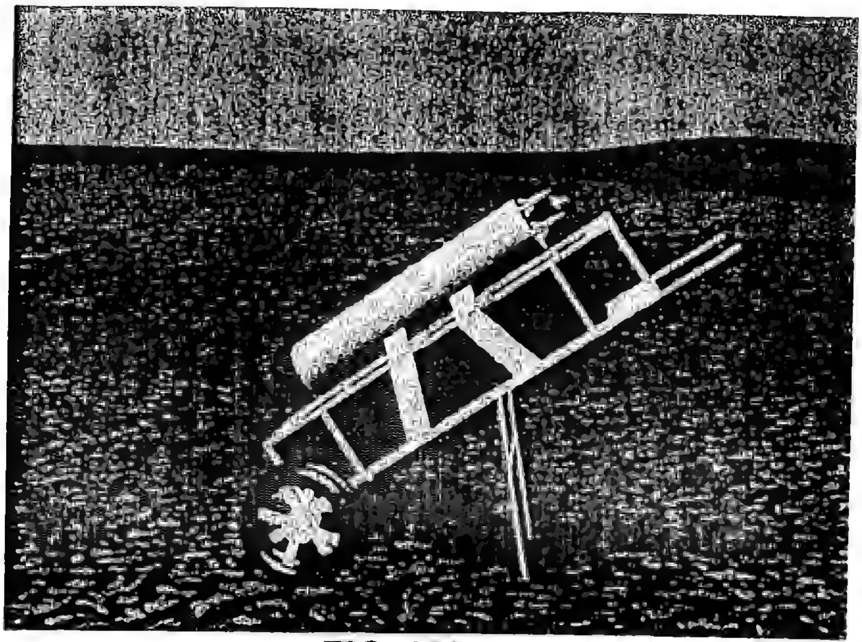


FIG. U1m

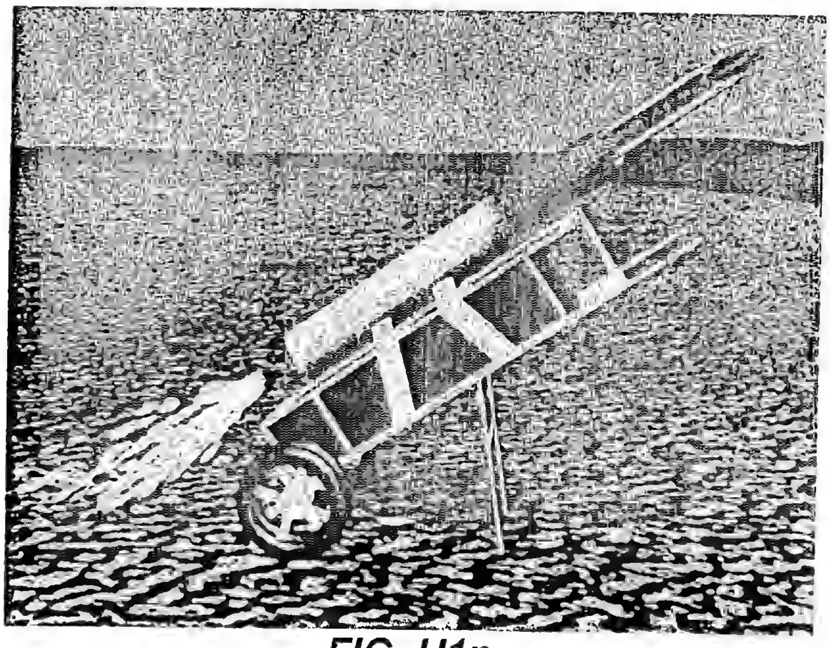


FIG. U1n

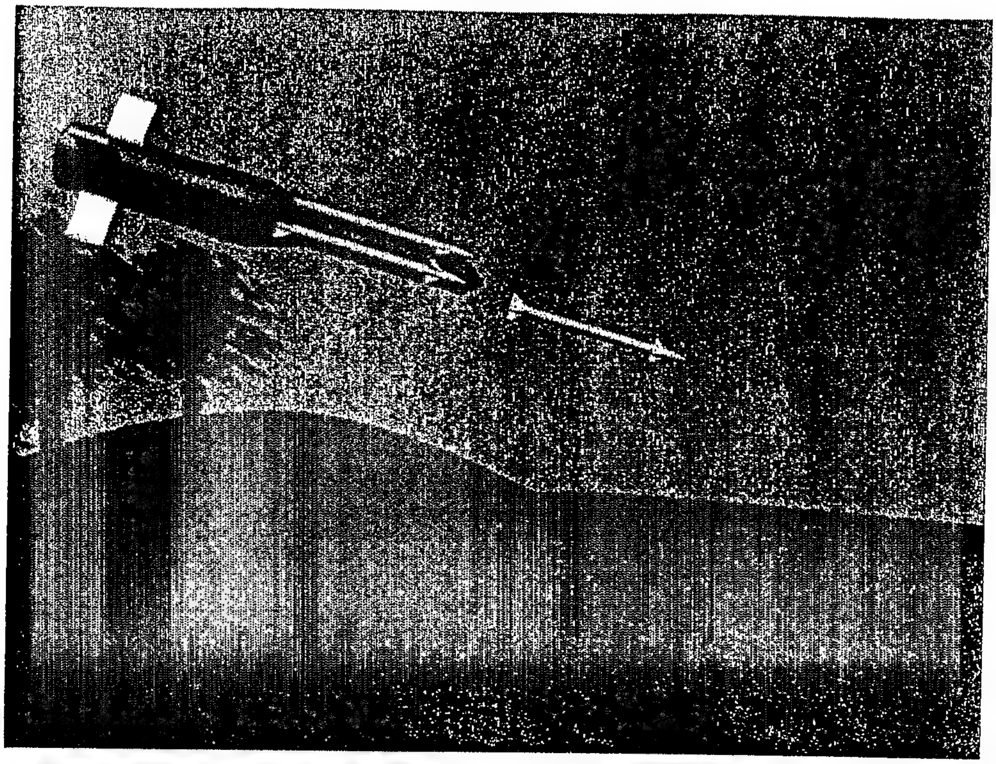


FIG. U1o

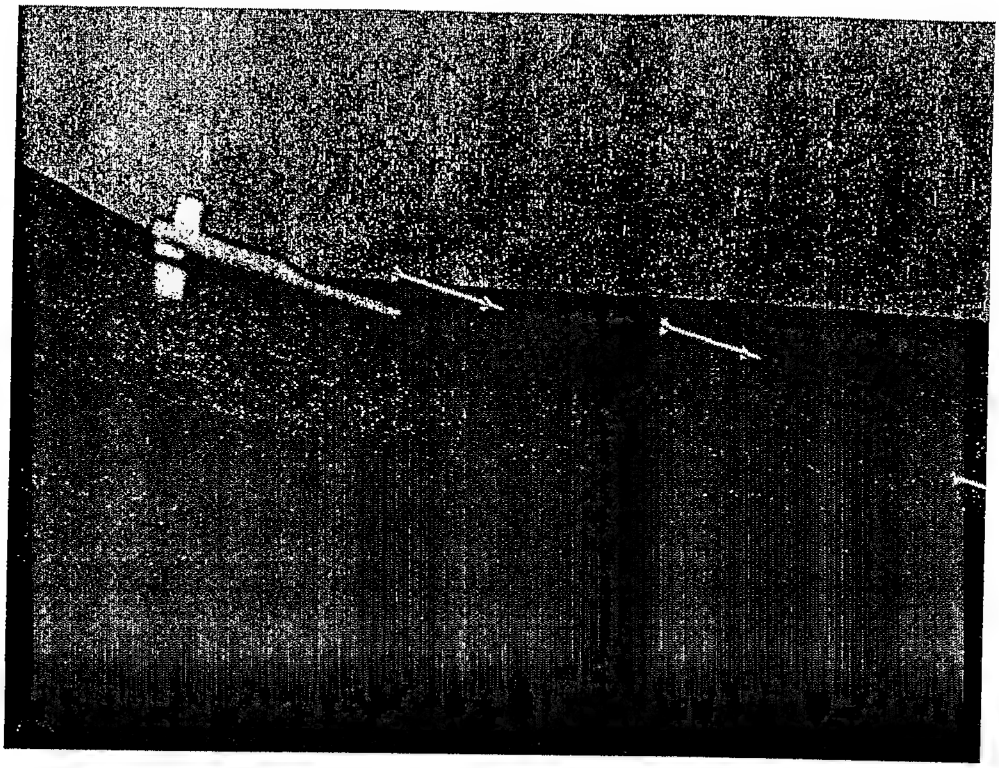


FIG. U1p

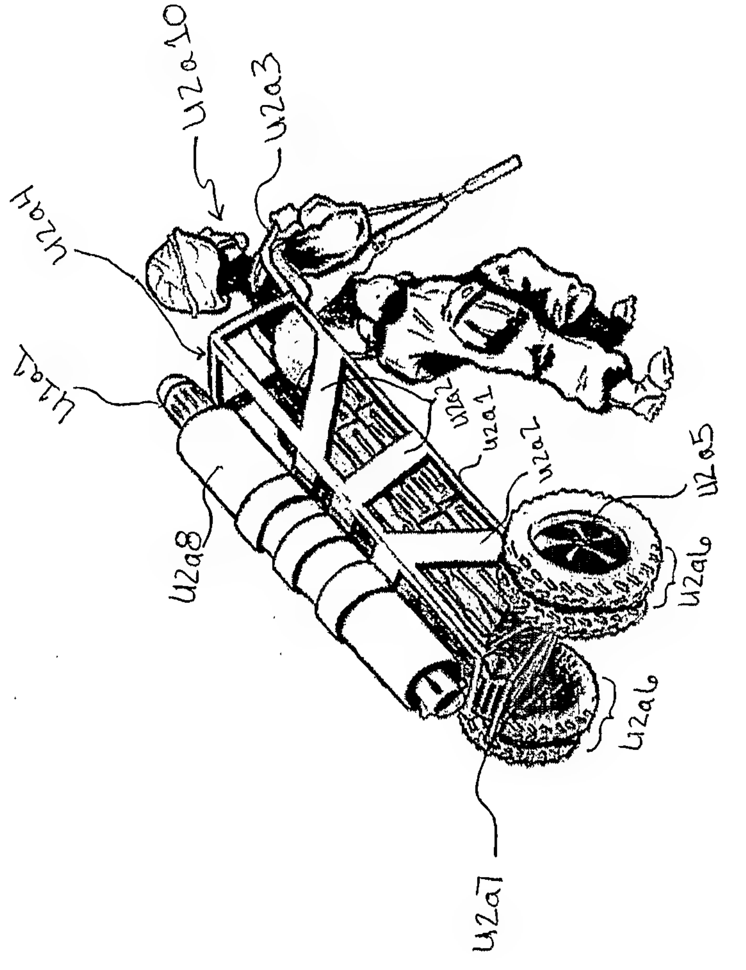


FIG. U2A

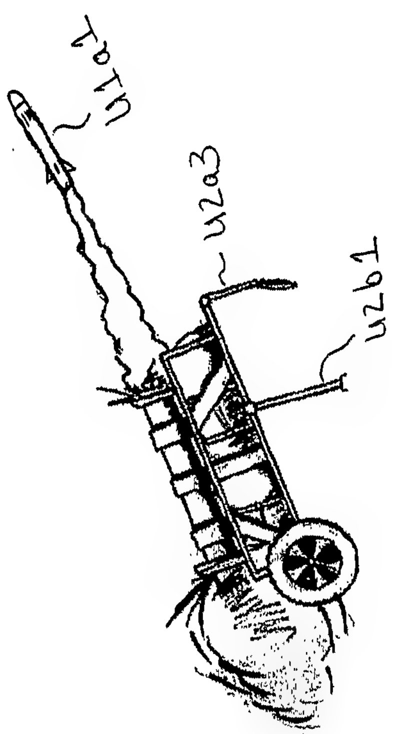


FIG. U2b

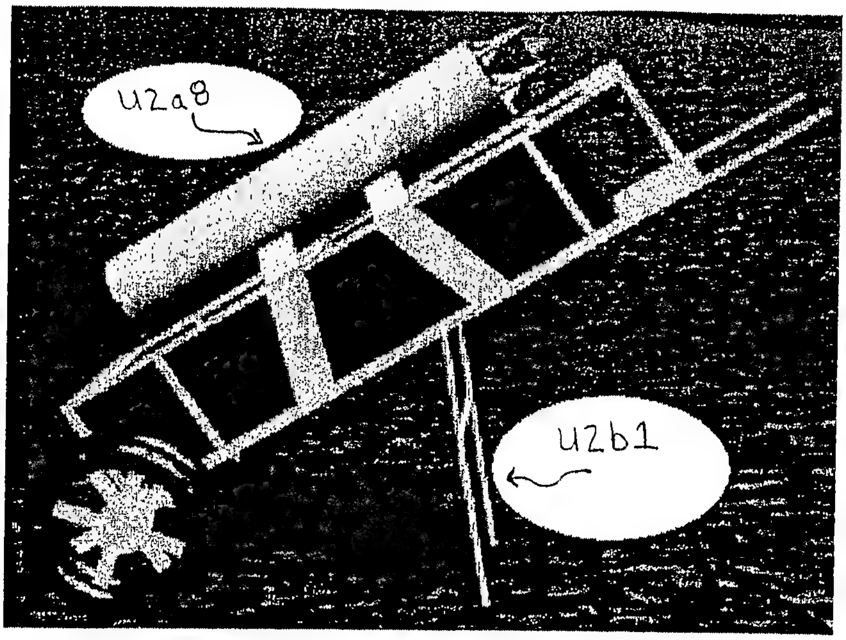


FIG. U2c

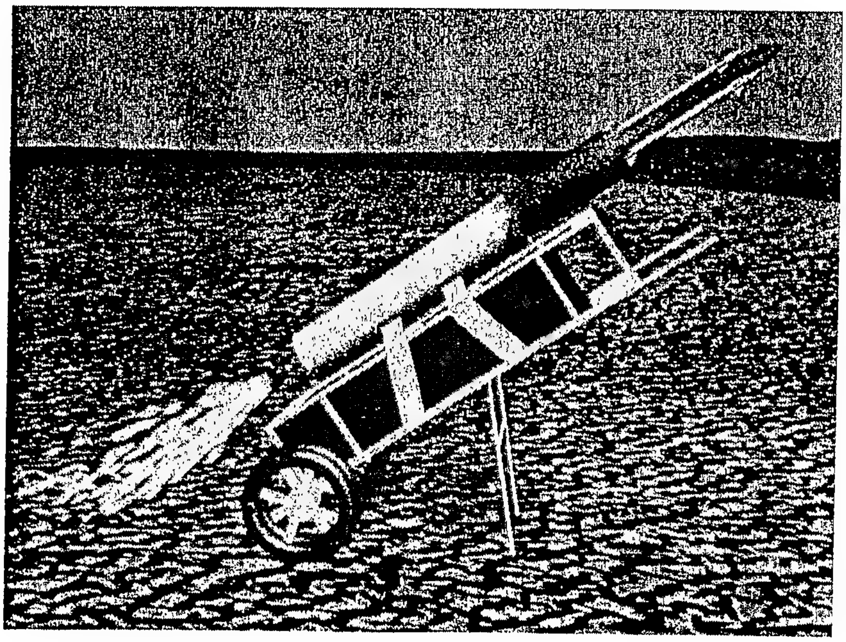


FIG. U2d

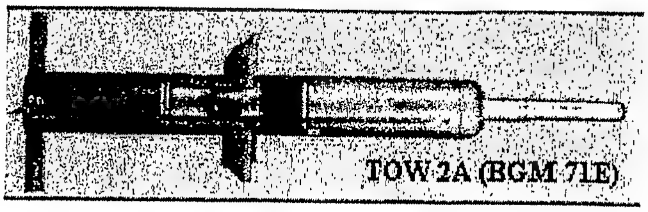


FIG U3a (Prior Art)

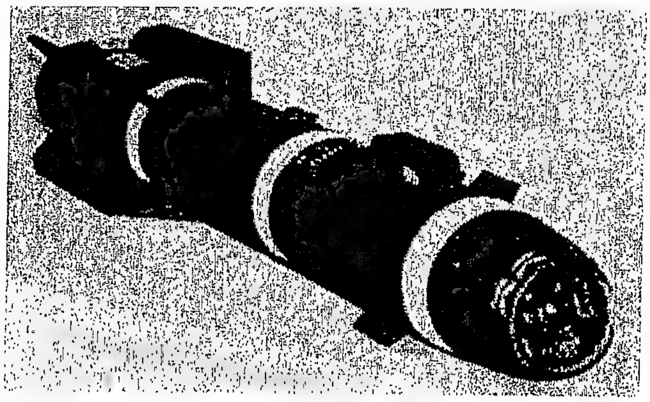


FIG U3b (Prior Art)

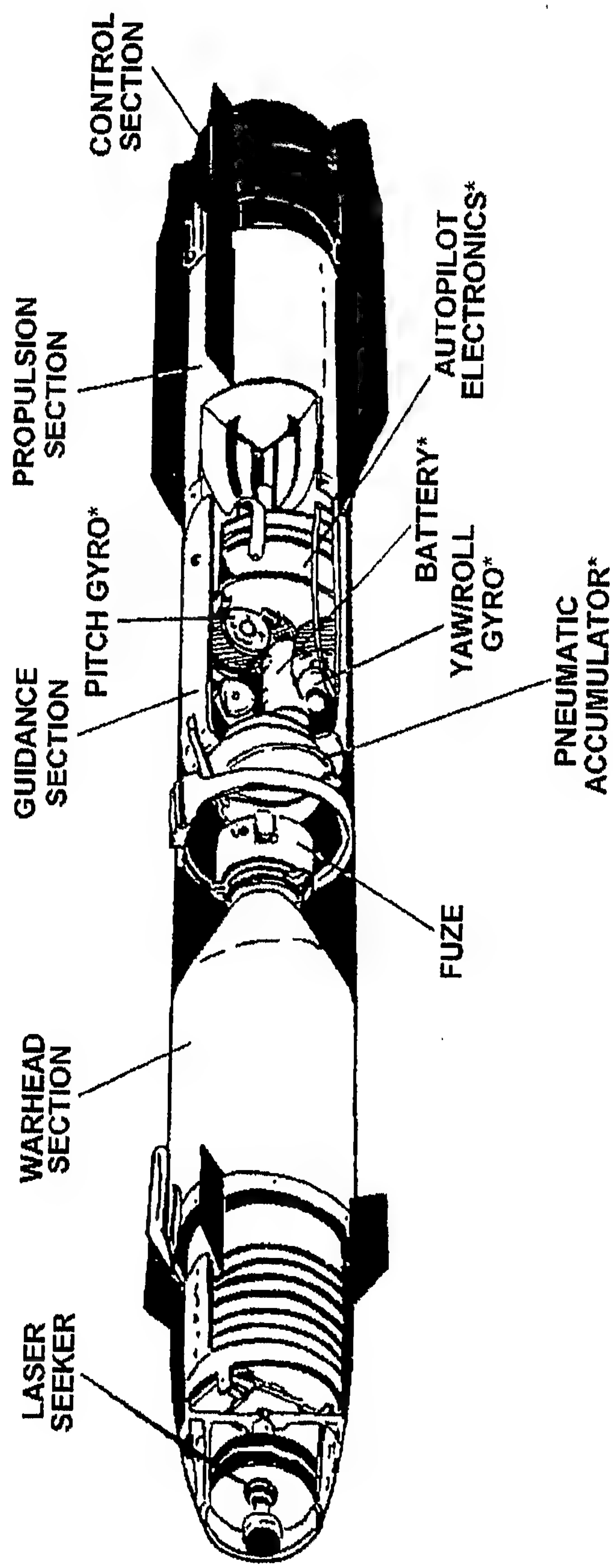


FIG. U3C (PRIOR ART)

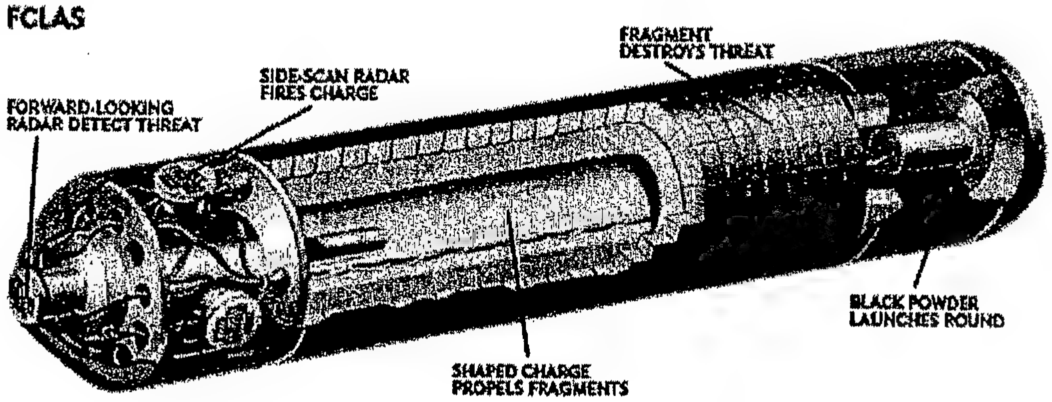


FIG U3d (Prior Art)

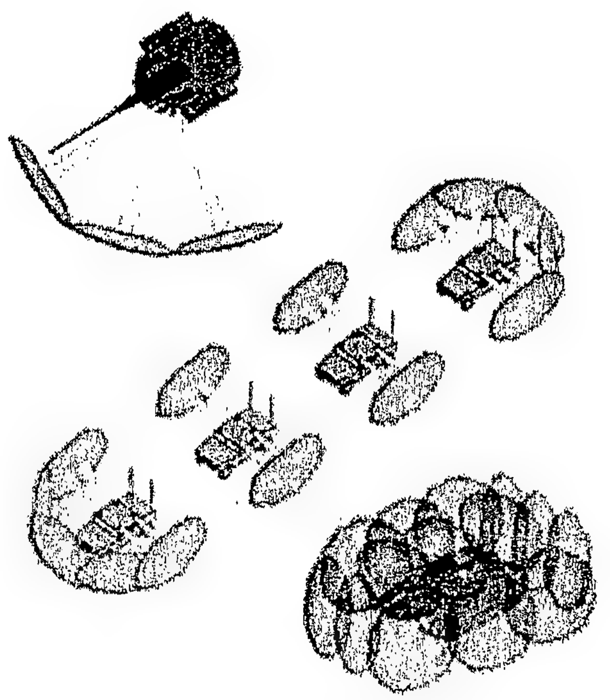


FIG U3e (Prior Art)

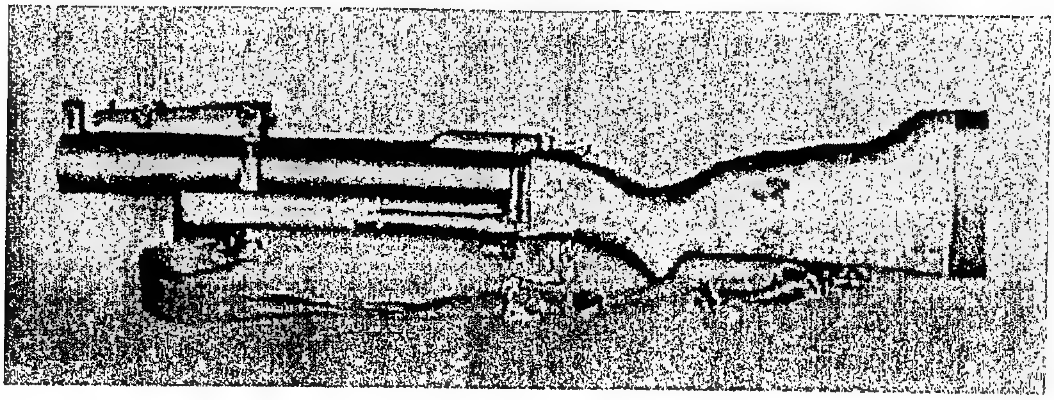


FIG. V1a M79 Grenade Launcher (Prior Art)

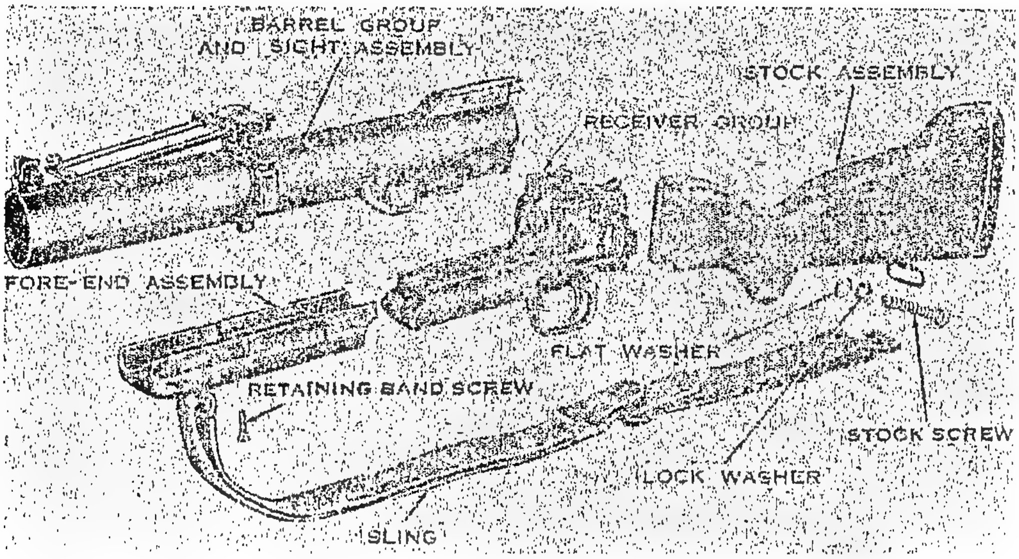


FIG. V1b M79 Grenade Launcher (Prior Art)

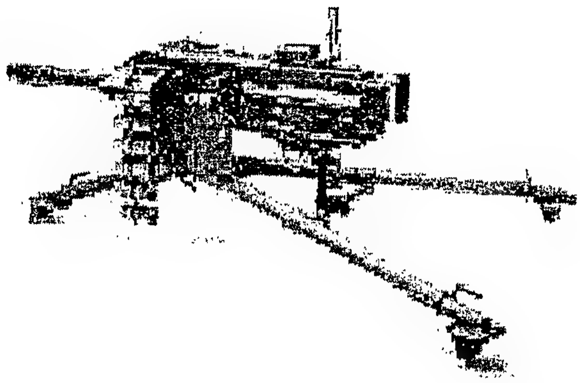


FIG. V1c MK 19 Grenade Launcher (Prior Art)

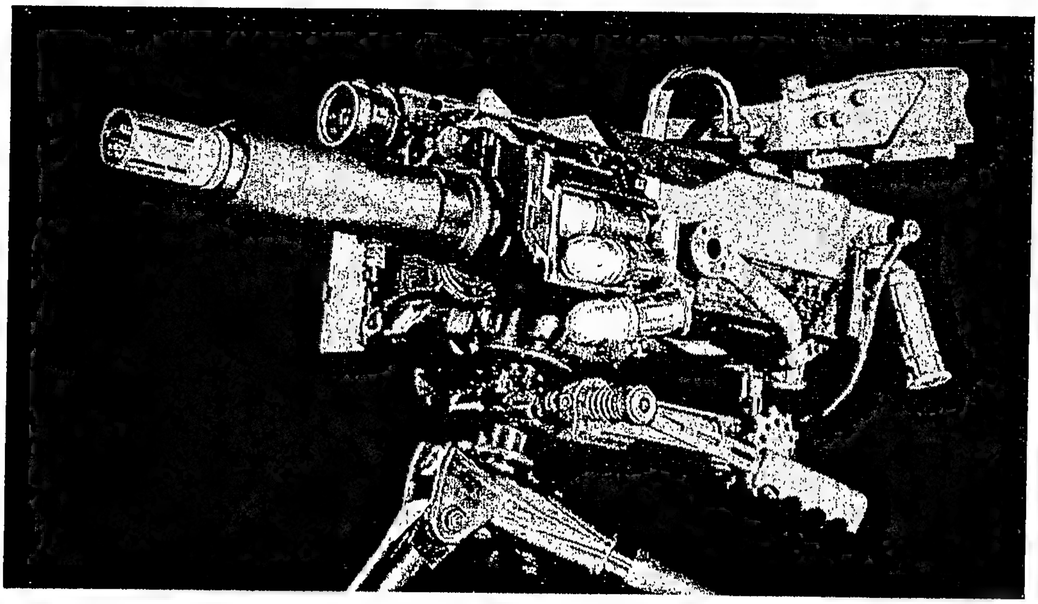


FIG. V1d MK 47 Grenade Launcher (Prior Art)

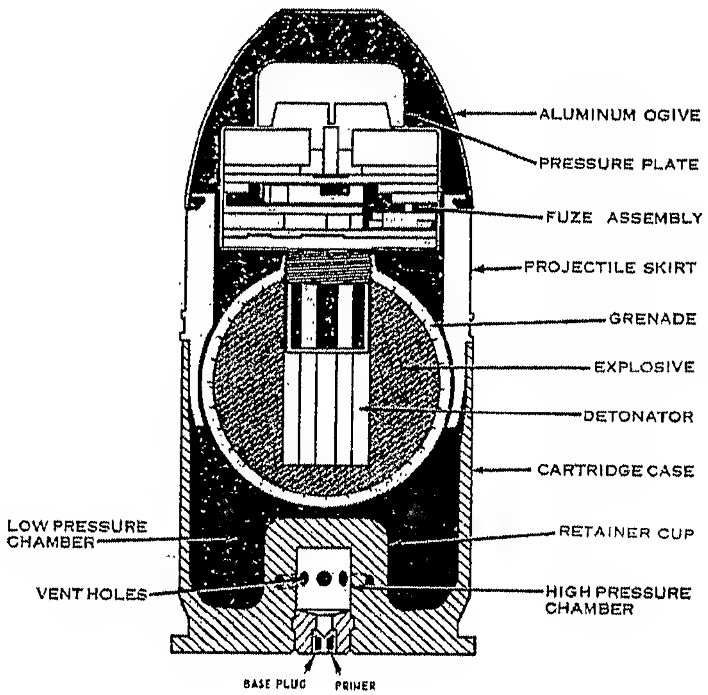


FIG. V1e 40 mm Grenade (Prior Art)

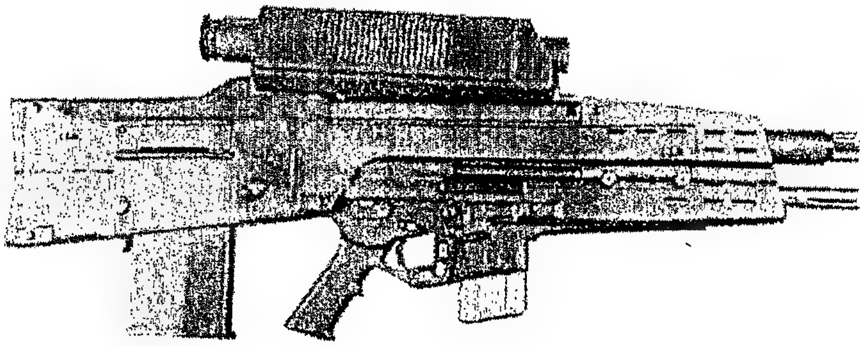


FIG. V1f OICW Assault Rifle (Prior Art)

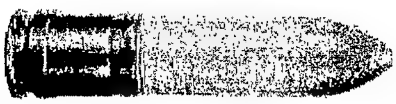


FIG. V1g 20 mm HEAB Grenade (Prior Art)

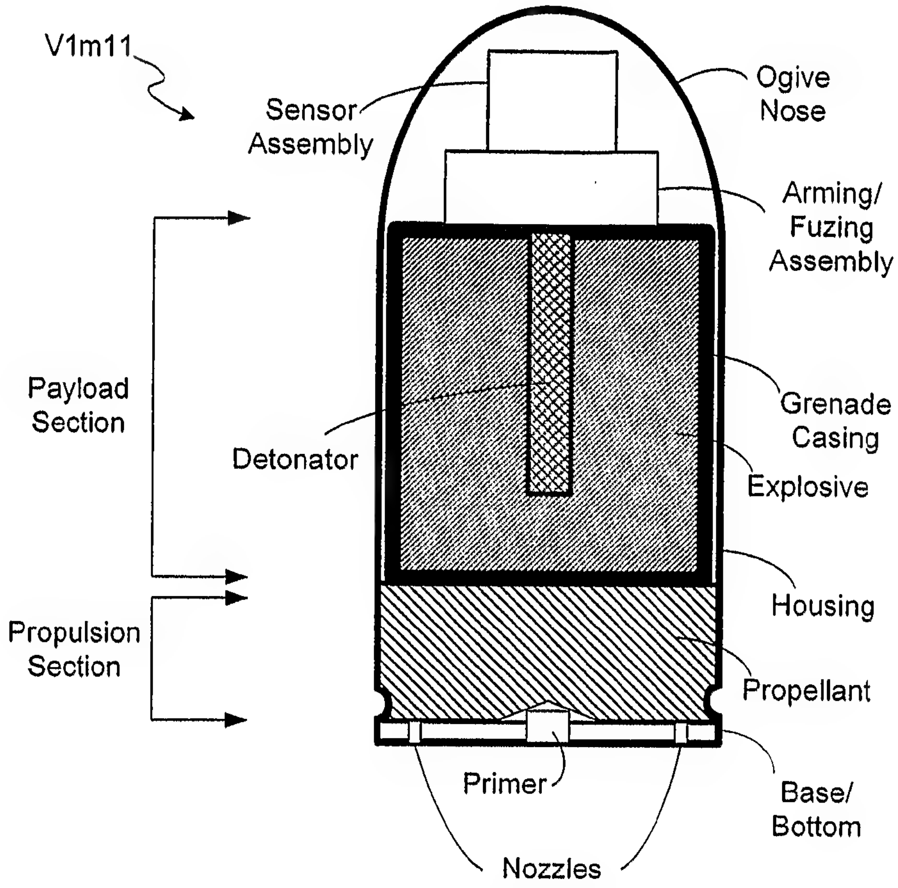


FIG. V1h

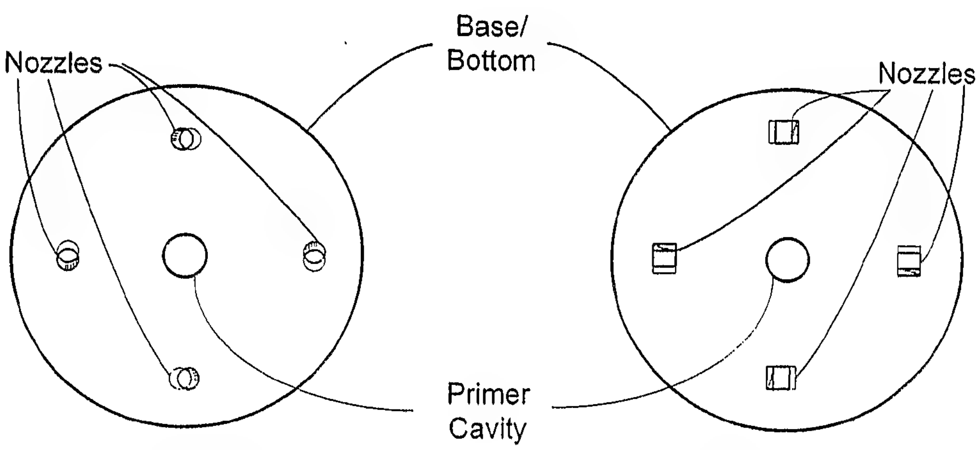


FIG. V1i

FIG. V1j

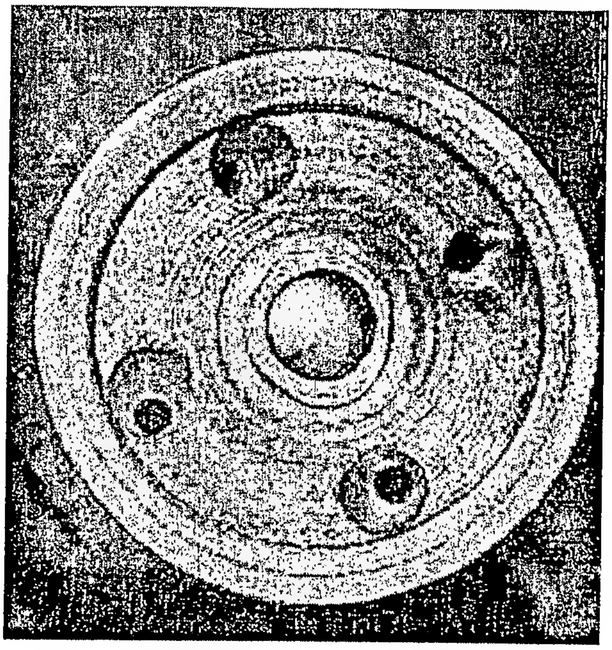


FIG. V1k Gyrojet Round (Rear) (Prior Art)

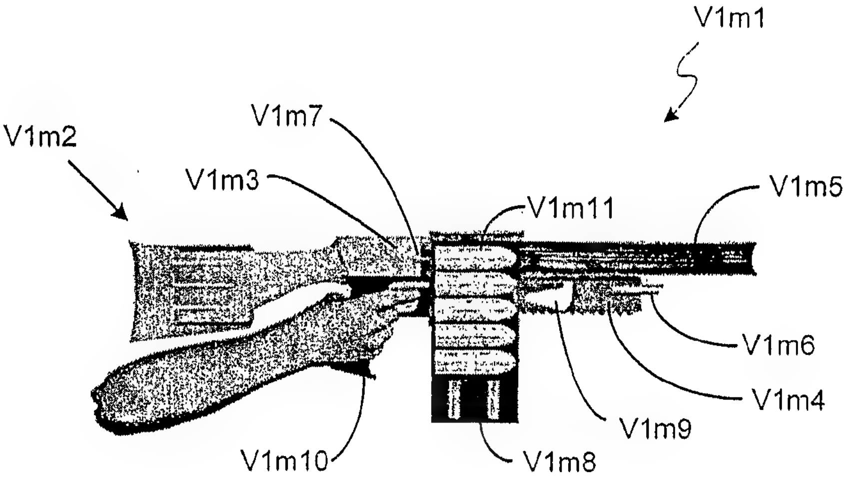


FIG. V1m Grenade Launcher

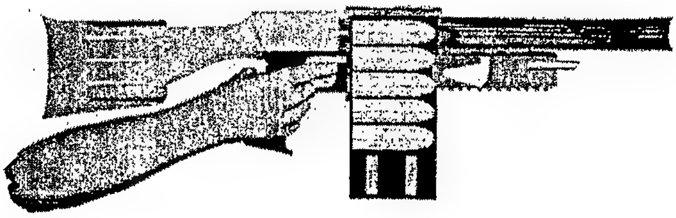


FIG. V2a

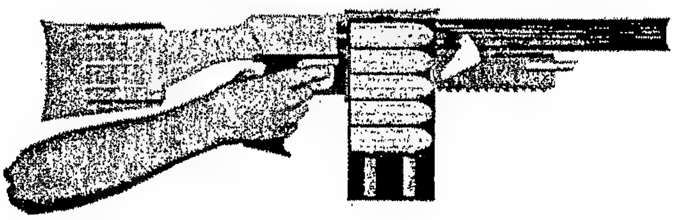


FIG. V2b

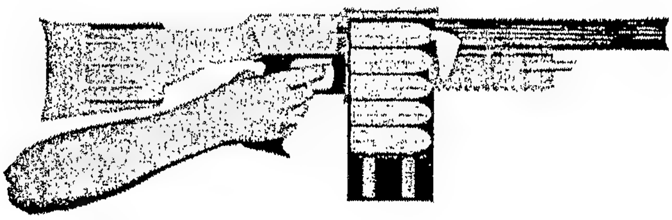


FIG. V2c

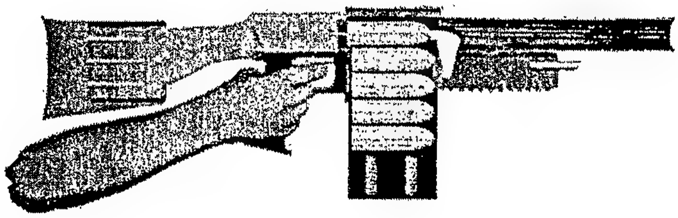


FIG. V2d

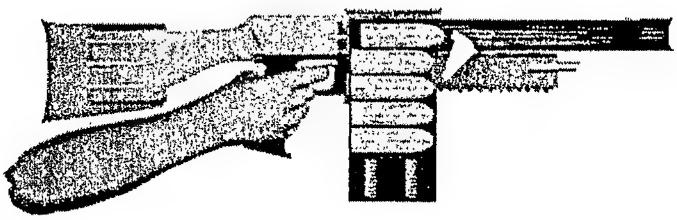


FIG. V2e

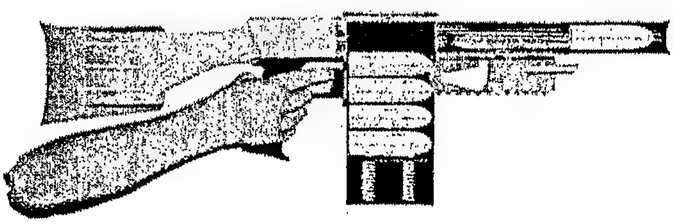


FIG. V2f

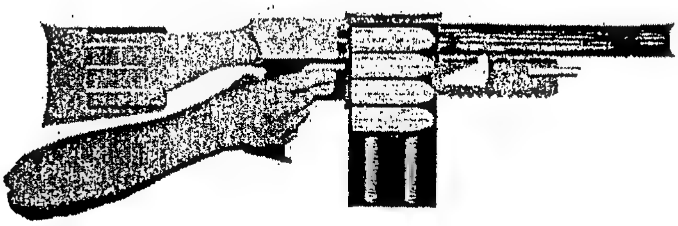


FIG. V2g

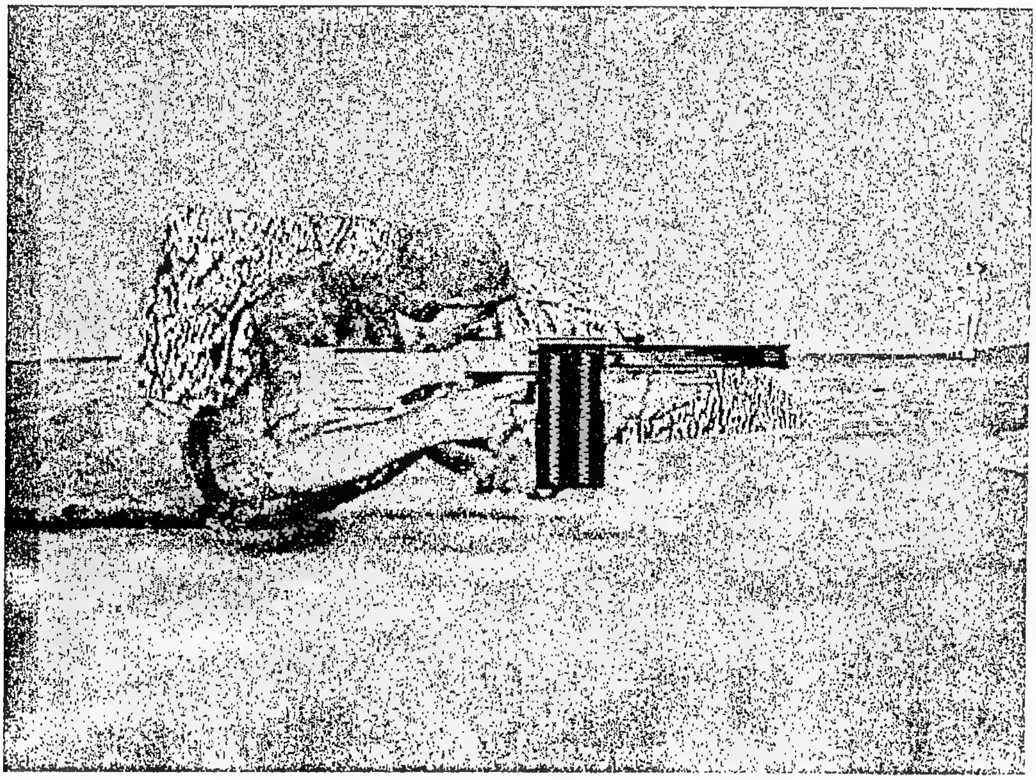


FIG. V3a

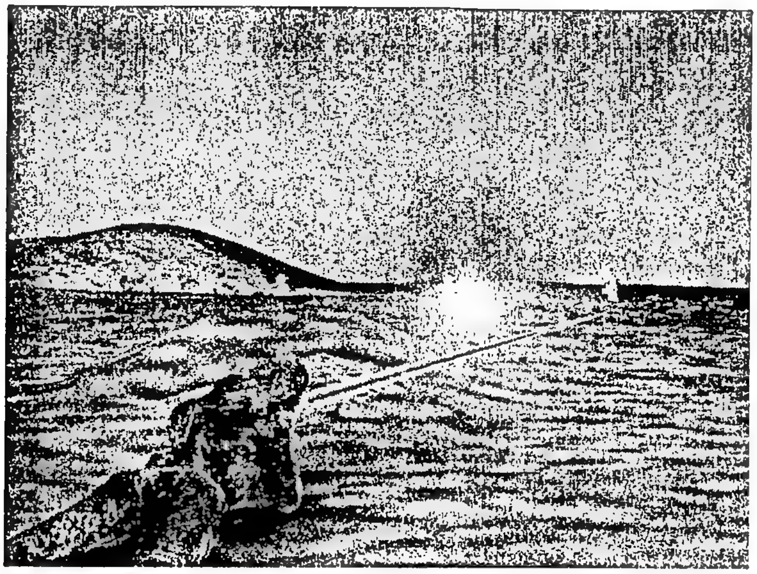


FIG. V3b

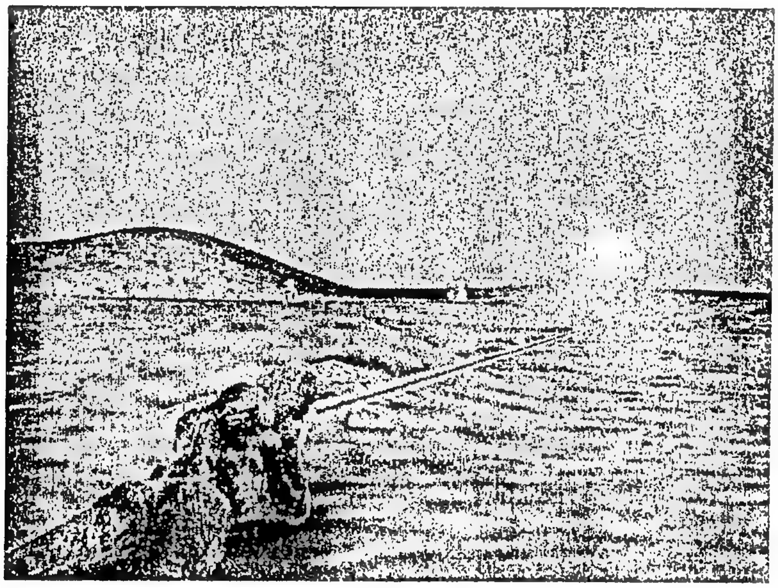


FIG. V3c

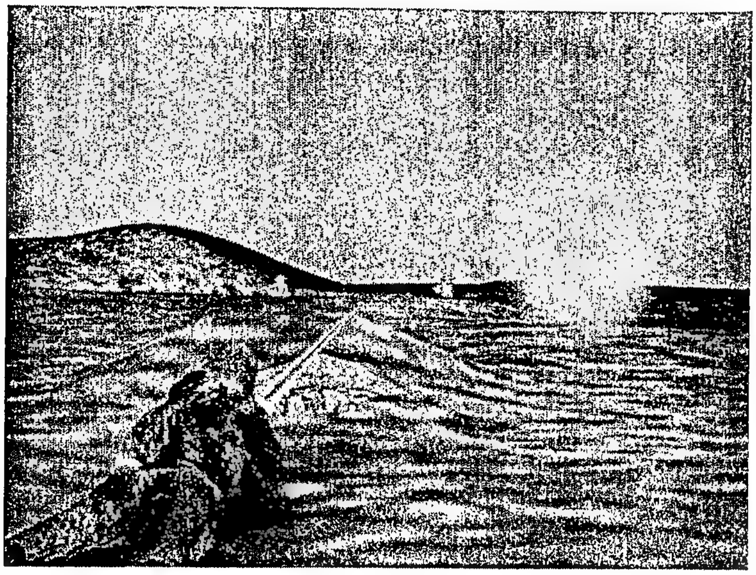


FIG. V3d

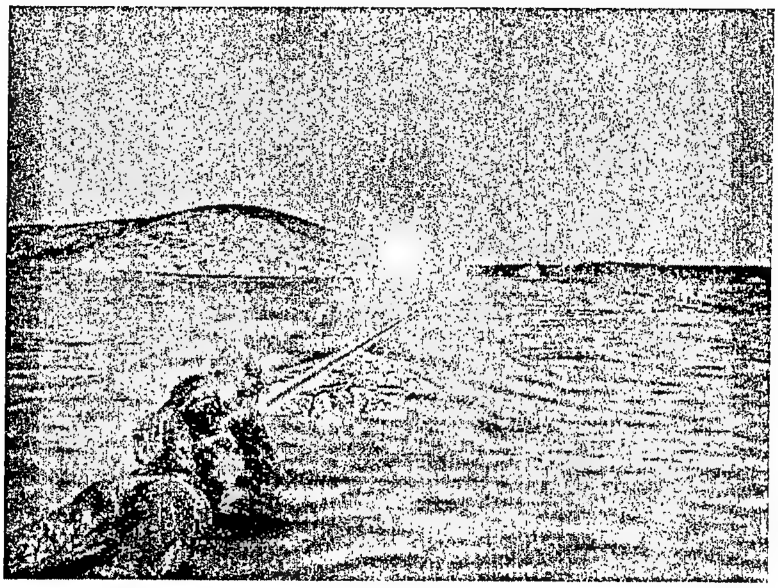


FIG. V3e

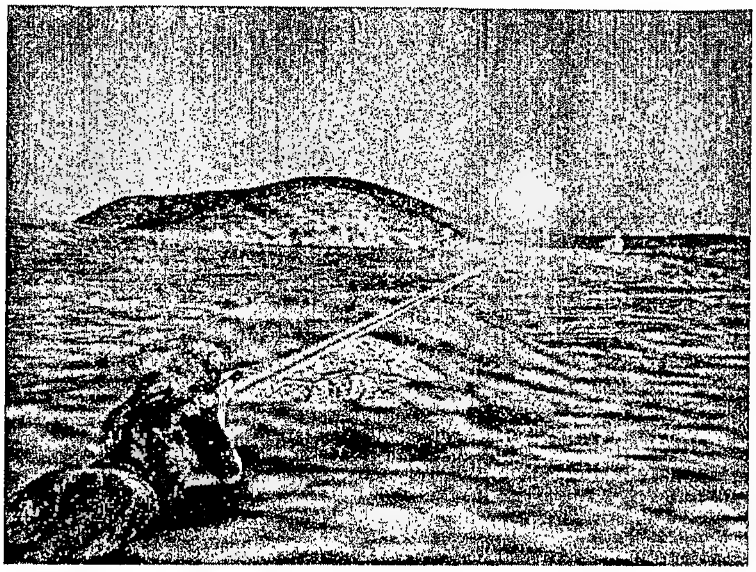


FIG. V3f

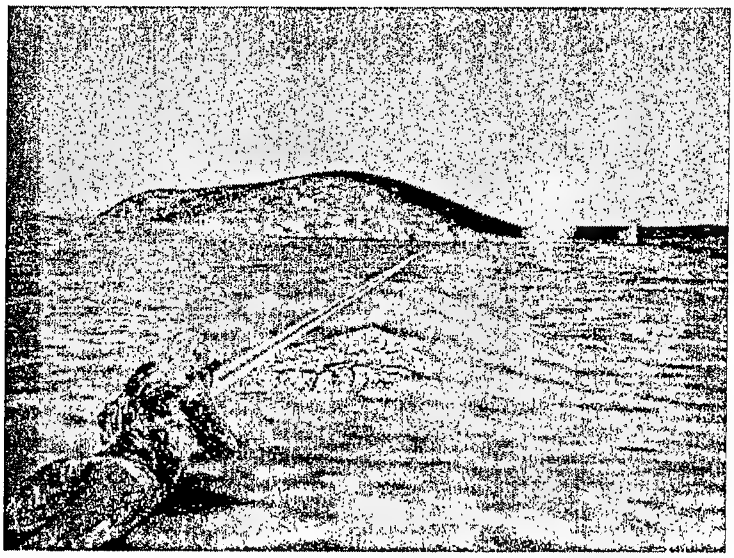


FIG. V3g

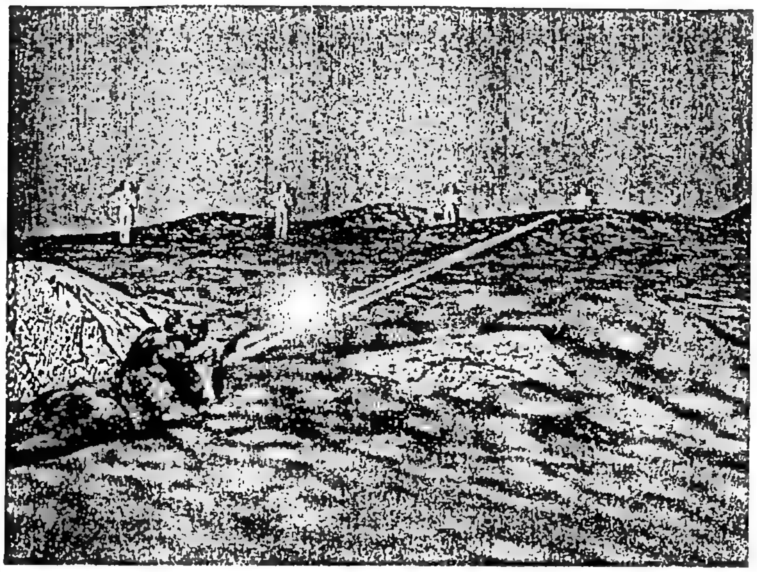


FIG. V3h

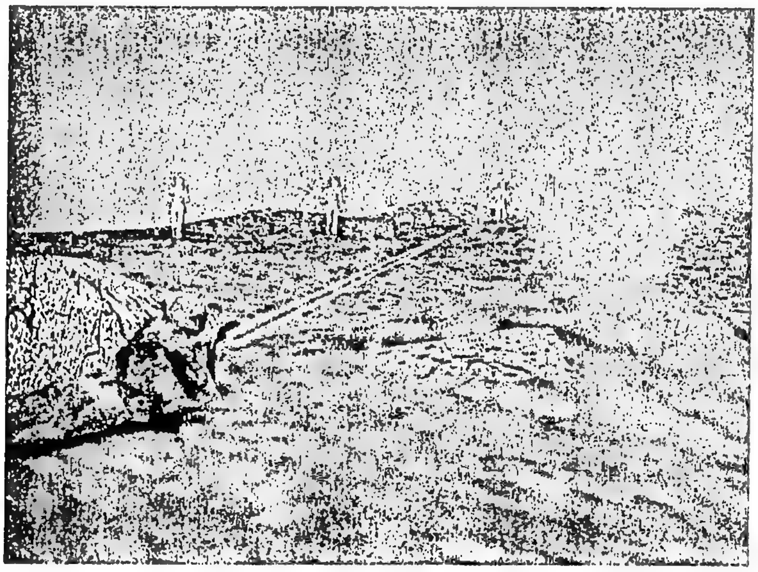


FIG. V3i

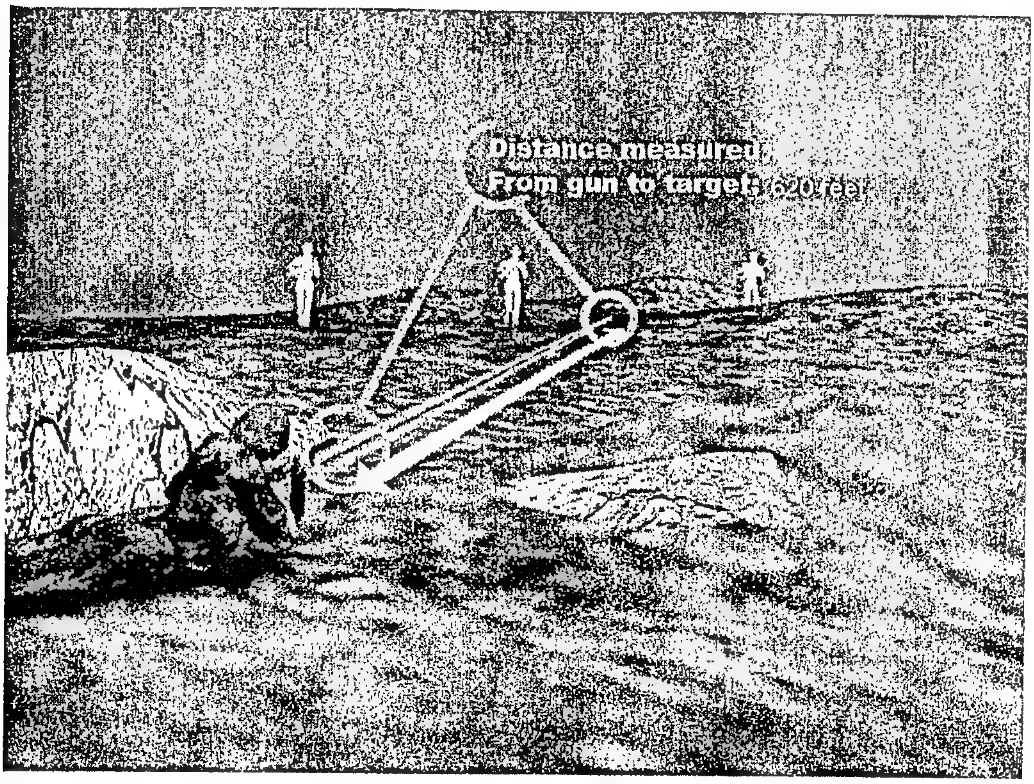


FIG. V3j

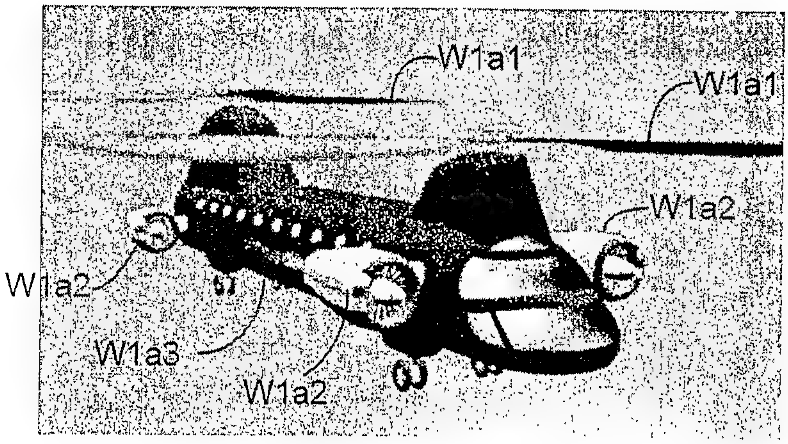


FIG. W1a

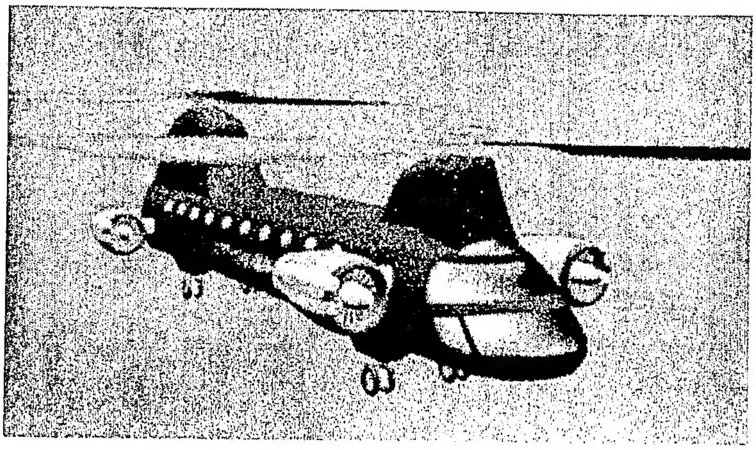


FIG. W1b

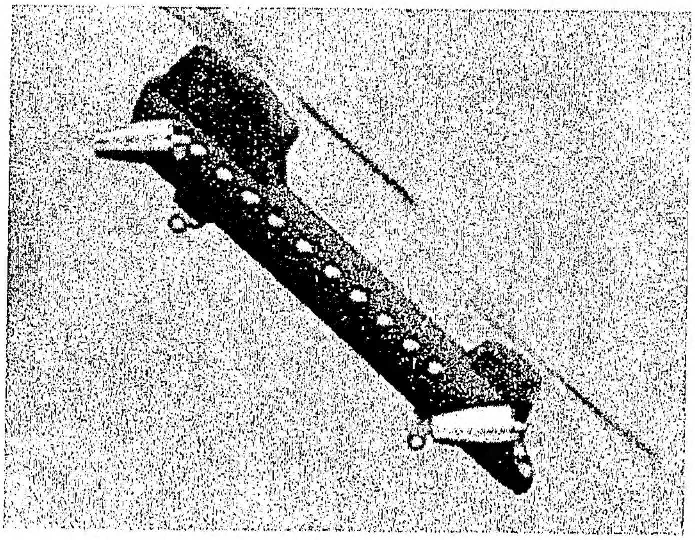


FIG. W1c

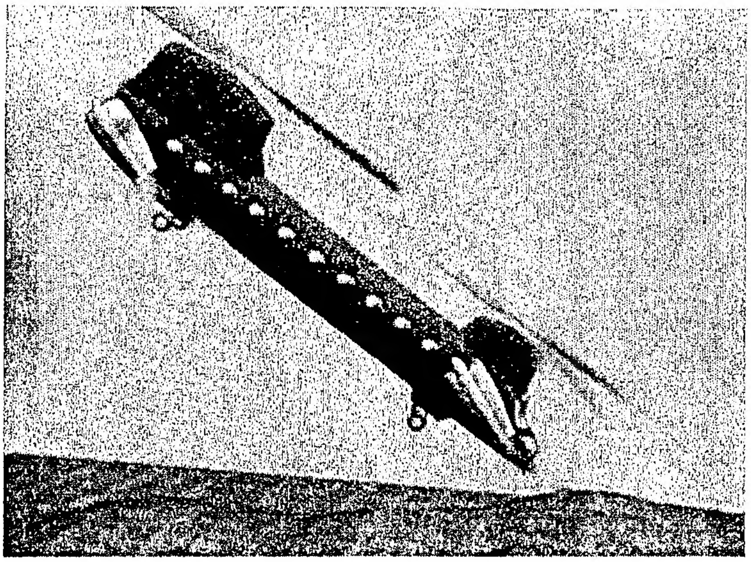


FIG. W1d

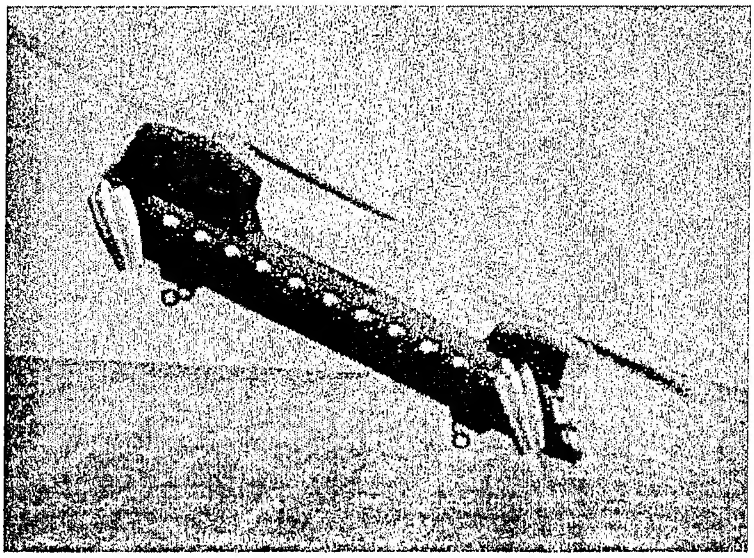


FIG. W1e

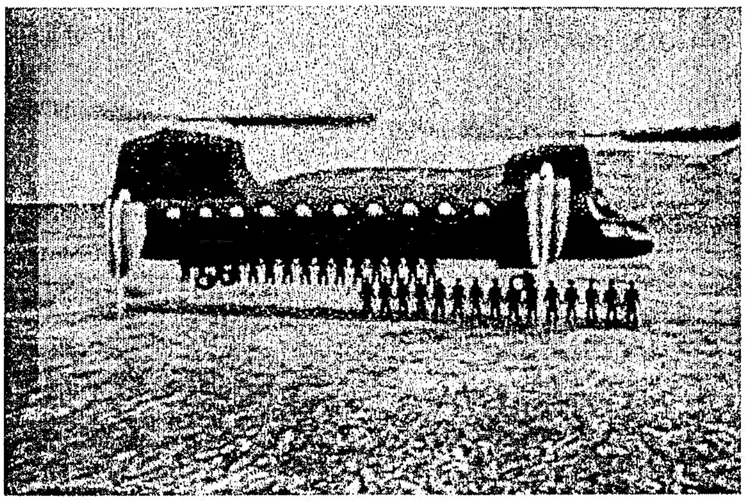


FIG. W1f

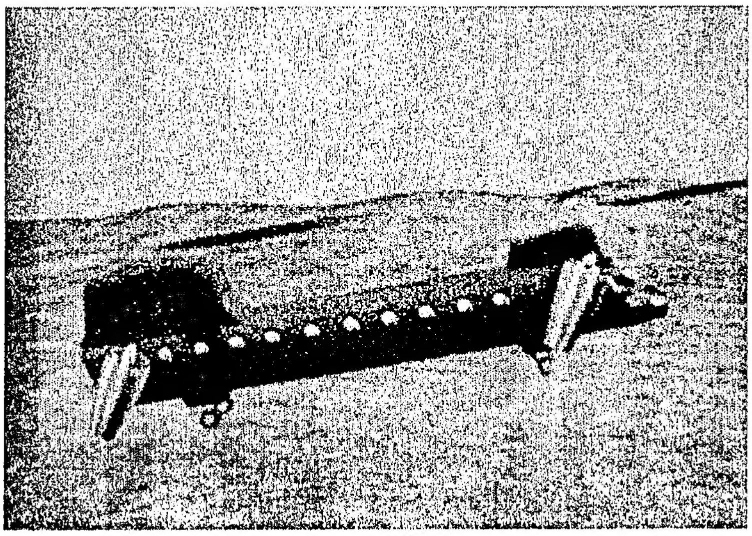


FIG. W1g

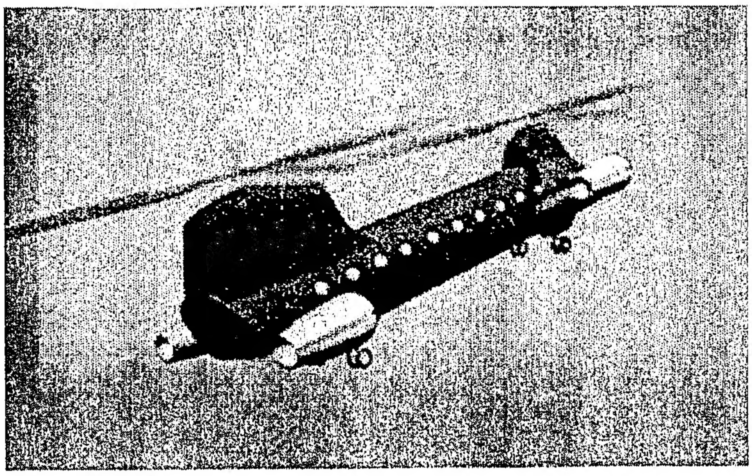


FIG. W1h

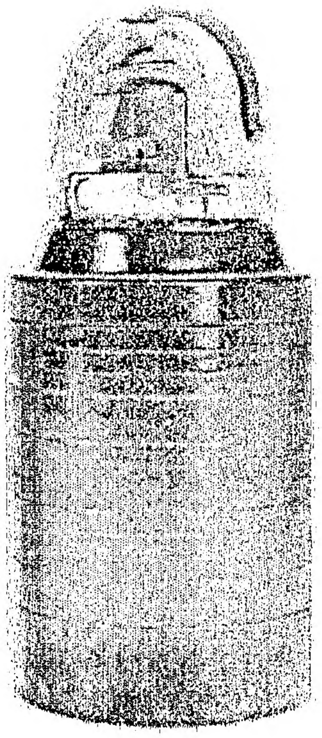


FIG. W1i (Prior Art)

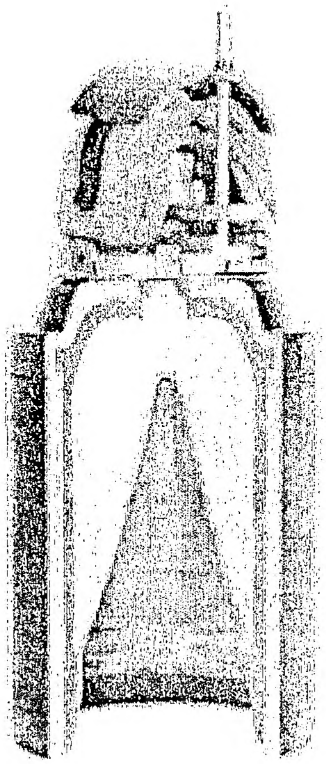


FIG. W1j (Prior Art)